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ECOSYSTEM DESCRIPTIONS
FOREST RANGE ENVIRONMENTAL STUDY

United States Forest Service

FRES

~~APPENDIX B~~

October 1, 1970

Ecosystem Descriptions

Forest Range Environmental Study

Forest Service, USDA

October 1970

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Ecosystem Descriptions (FRES Eco. 10-44)

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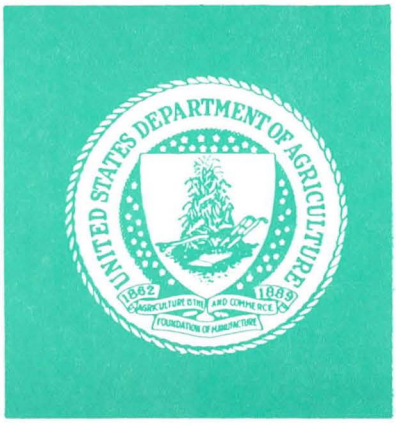

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ECOSYSTEMS IN THE FOREST RANGE ENVIRONMENTAL STUDY

All land area of the 50 United States is included in this study. Land normally considered "rangeland," "forest land," and "desert" or "barren" is aggregated into 40 FRES ecosystems. The sum of all 40 FRES ecosystems represents the total existing national forest and range environment. The remaining land is accounted for under major categories that include improved pasture, cropland, and miscellaneous land uses. (Tables are being prepared.)

A. W. Küchler's (1964) scheme of vegetation mapping (and his revised map of 1965 and 1966) has been used as a basis for aggregating many plant communities (phytocoenoses) into ecosystems. 1/ Küchler's work is an approximation of the potential natural vegetation for all land areas of the 50 States. To simplify data compilations, the forest and woodland ecosystems were made synonymous with the broad geographic forest types described by the Forest Survey conducted by the Forest Service. 2/

Many of the "real vegetation types" of today will be managed so that they will never develop to the Küchler potential base. Nevertheless, this concept of potential vegetation provides a realistic common denominator for classification. It is quite widely accepted. Therefore, parallels were established between the commonly used vegetation types of other land inventory systems and the types established by Küchler. In this way data from the Bureau of Land Management, Bureau of Indian Affairs, Soil Conservation Service, National Park Service, Fish and Wildlife Service, and Forest Service were incorporated into an inventory of land by ecosystems. 3/ Meanwhile, the geographical and political boundary delineations necessary for identification of the system were retained.

An individual ecosystem, as used in the study, may contain a single major plant community or many major plant communities. In all cases, closely related communities are aggregated into a specific ecosystem. For example, all of the many existing grassland communities are aggregated into eight grassland ecosystems. A second example: the pinyon-juniper community by itself is maintained as an ecosystem for this study. Since data are not readily available from each one of the grassland or other communities, the outputs from this study are merely approximations of resource product yield from the major community aggregation--the ecosystem.

1/ Küchler, A.W., 1964, Manual to accompany the map--Potential Vegetation of the Conterminous United States. American Geographical Society. Special publication No. 36, 116 pp. with map, revised editions of 1965 and 1966.

2/ Geographic forest types used in the Forest Survey. U.S. Forest Service Handbook 4813.1, Section 74, March 1967.

3/ Acreages of the remaining Federal lands administered by other Federal agencies were included. They were apportioned to FRES ecosystems using the best judgment available in the general absence of resource data of the kind needed for FRES.

A list of FRES ecosystems follows:

Name	Code	Name	Code
White-red-jack pine	10	Desert shrub	30
Spruce-fir	11	Shinnery	31
Longleaf-slashpine	12	Texas savanna	32
Loblolly-shortleaf pine	13	Southwestern shrubsteppe	33
Oak-pine	14	Chaparral-mountain shrub	34
Oak-hickory	15	Pinyon-juniper	35
Oak-gum-cypress	16	Mountain grasslands	36
Elm-ash-cottonwood	17	Mountain meadows	37
Maple-beech-birch	18	Plains grasslands	38
Aspen-birch	19	Prairie	39
Douglas-fir	20	Desert grasslands	40
Ponderosa pine	21	Wet grasslands	41
Western white pine	22	Annual grasslands	42
Fir-spruce	23	Hawaiian grasslands	43
Hemlock-sitka spruce	24	Alpine	44
Larch	25	Tundra	45
Lodgepole pine	26	Muskeg	46
Redwood	27	Heath	47
Hardwoods	28	Aleutian meadows	48
Sagebrush	29	Desert	49

A detail listing showing which Küchler communities are contained within each FRES ecosystem begins on the following page. The Küchler communities included within each are identified by Küchler's number and name (i.e., K-86 Great Lakes pine forest). By definition of established usage, many Forest Survey types are seral stages in forest development. They do not mesh in all cases with Küchler phytocoenoses. Thus, some Küchler types appear in more than one FRES ecosystem.

Forest and Woodland Ecosystems in the Forest Range Environmental Study

10. White-red-jack pine 4/

K-86 Great Lakes pine forest

11. Spruce-fir

K-2A Spruce-birch forests 5/
K-3A Black spruce forests 5/
K-5A Alder thickets 5/
K-84 Great Lakes spruce-fir forest
K-85 Conifer bog
K-97 Northeastern spruce-fir forest
K-88 Southeastern spruce-fir forest

12. Longleaf-slashpine

K-102 Southern mixed forest (seral stages)
K-106 Subtropical pine forest (So. Florida)

13. Loblolly-shortleaf pine

K-100 Northeastern oak-pine forest
K-101 Oak-hickory-pine forest
K-104 Pocosin
K-105 Sandpine scrub

14. Oak-pine

K-101 Oak-hickory-pine forest
K-102 Southern mixed forest

15. Oak-hickory

K-72 Oak savanna
K-73 Mosaic of bluestem prairie (K-66)
K-75 Cross timbers
K-80 Black belt
K-91 Oak-hickory forest
K-95 Appalachian oak forest

4/ Numbers and names (i.e., K-1 Spruce-cedar-hemlock forest) are those assigned by Küchler (1965 map: Potential Natural Vegetation. USGS National Atlas Sheet No. 90), except as otherwise noted.

5/ Küchler types taken from 1966 map: Potential Natural Vegetation of Alaska. USGS National Atlas Sheet No. 89.

16. Oak-gum-cypress

K-81 Liveoak-sea oats
K-82 Cypress savanna
K-96 Mangrove
K-103 Southern floodplain forest

17. Elm-ash-cottonwood

K-89 Northern floodplain forest
K-92 Elm-ash forest

18. Maple-beech-birch

K-90 Maple-basswood forest
K-93 Beech-maple forest
K-94 Mixed mesophytic forest
K-97 Northern hardwoods
K-98 Northern hardwoods-fir forest
K-99 Northern hardwoods-spruce forest

19. Aspen birch

K-97 Northern hardwoods (seral stages)
K-98 Northern hardwoods-fir forest (seral stages)
K-99 Northern hardwoods-spruce forest (seral stages)

20. Douglas fir

K-2 Cedar-hemlock-Douglas fir forest
K-11 Douglas fir forest
K-24 Mosaic cedar-hemlock-Douglas fir forest (K-2) and Oregon oakwoods (K-22)
K-25 California mixed evergreen forest

21. Ponderosa pine

K-5 Mixed conifer forest
K-9 Pine-cypress forest
K-10 Western ponderosa forest
K-15 Eastern ponderosa forest
K-16 Black Hills pine forest
K-17 Pine-Douglas fir forest
K-18 Arizona pine forest

22. Western white pine

K-12 Cedar-hemlock-pine forest

23. Fir-spruce

K-3 Silver fir-Douglas fir forest
K-4 Fir-hemlock forest
K-7 Red fir forest
K-14 Western spruce-fir forest
K-19 Spruce-fir-Douglas fir forest
K-20 Southwestern spruce-fir forest

24. Hemlock-sitka spruce

K-1 Spruce-cedar-hemlock forest
K-1A Hemlock-spruce forest (Alaska) 5/

25. Larch

K-13 Grand fir-Douglas fir forest

26. Lodgepole pine 6/

K-8 Lodgepole pine-subalpine forest

27. Redwood

K-6 Redwood forest

28. Hardwoods

K-22 Oregon oakwoods
K-26 California oakwoods
K-2H Guava mixed forest 7/
K-3H Ohia-lehua forest 7/
K-5H Koa forest 7/
K-6H Koa-mamani parkland 7/

6/ Contains Forest Survey local types 95-Bristlecone pine and 96-White-bark pine that are classified by the Forest Survey as noncommercial but generally occurring in ecosystems related to others included under this general description.

7/ Küchler types taken from 1966 map: Potential Natural Vegetation of Hawaii. USGS National Atlas Sheet No. 89.

Shrubland Ecosystems in the Forest Range Environmental Study

29. Sagebrush

K-32 Great Basin sagebrush
K-49 Sagebrush steppe
K-50 Wheatgrass-needlegrass shrubsteppe

30. Desert Shrub

K-23 Mesquite bosques
K-33 Blackbrush
K-34 Saltbush-greasewood
K-35 Creosote bush
K-36 Creosote bush-bur sage
K-37 Palo verde-cactus shrub

31. Shinnery

K-64 Shinnery

32. Texas savanna

K-38 Ceniza shrub
K-54 Mesquite-acacia savanna
K-55 Mesquite-liveoak savanna
K-77 Juniper-oak savanna
K-78 Mesquite-oak savanna

33. Southwestern shrubsteppe

K-52 Grama-tobosa shrubsteppe
K-53 Trans-Pecos shrub savanna

34. Chaparral-Mountain Shrub

K-27 Oak-juniper woodland
K-28 Transition between oak-juniper woodlands (K-27) and Mountain mahogany-oak scrub (K-31)
K-29 Chaparral
K-30 Coastal sagebrush
K-31 Mountain mahogany-oak scrub

35. Pinyon-juniper

K-21 Pinyon-juniper woodlands

Grassland Ecosystems in the Forest Range Environmental Study

36. Mtn. Grasslands

K-40 Fescue-oatgrass
K-43 Fescue-wheatgrass
K-44 Wheatgrass-bluegrass
K-46 Fescue-mountain muhly prairie
K-56 Foothills prairie

37. Mountain Meadows

(Not recognized by Küchler; included in FRES because of their management significance.)

38. Plains Grasslands

K-57 Grama-needlegrass-wheatgrass
K-58 Grama-buffalo grass
K-59 Wheatgrass-needlegrass
K-60 Wheatgrass-bluestem-needlegrass
K-61 Wheatgrass-grama-buffalo grass
K-62 Bluestem-grama prairie
K-76 Mesquite-buffalo grass

39. Prairie

K-63 Sandsage-bluestem prairie
K-66 Bluestem prairie
K-67 Nebraska sandhills prairie
K-68 Blackland prairie
K-69 Bluestem-sacahuiste prairie
K-74 Cedar glades
K-79 Fayette prairie

40. Desert Grasslands

K-47 Grama-galleta steppe
K-48 Grama-tobosa prairie
K-51 Galleta-three awn shrubsteppe

41. Wet Grasslands

K-42 Tule marshes
K-65 Northern cordgrass prairie
K-70 Southern cordgrass prairie
K-71 Palmetto prairie
K-83 Everglades

42. Annual Grasslands

K-41 California steppe

43. Hawaiian Grasslands 7/

K-1H Schlerophyllous forest shrubland & grassland
K-4H Lama-manele forest
K-7H Grassland, microphyllous shrubs, & barren

Alpine Ecosystems in the Forest Range Environmental Study

44. Alpine

K-45 Alpine meadows and barren

Arctic Ecosystems in the Forest Range Environmental Study 5/ (Non-forest)

45. Tundra

K-6A Cottonsedge tundra
K-7A Watersedge tundra

46. Muskeg

K-4A Muskeg

47. Heath

K-8A Dryas meadows and barren
K-10A Aleutian heath and barren

48. Aleutian meadows

K-9A Aleutian meadows

Desert Ecosystems in the Forest Range Environmental Study

49. Desert

K-39 Desert

(Note: See definition page 3 for other desert areas.)

PRODUCTIVITY AND CONDITION CLASSIFICATIONS FOR FOREST ECOSYSTEMS

Classifications of productivity and condition in FRES differ for forest and for nonforest ecosystems. For the nonforest ecosystems, traditional concepts and data for evaluating productivity and condition in relation to range management are available. To extrapolate these concepts derived for Forest Service range to all categories of ownership is comparatively easy. For forest ecosystems, the productivity and condition classifications had to be changed. Because the Forest Survey provides the best data on forest ecosystems, its procedures for evaluating productivity and condition were adapted to meet the needs of FRES. Fortunately, the Forest Survey, through Task I of the 1970 Timber Review, will be able to break out the Nation's forest ecosystems in terms of ownership, site productivity class, and stand condition.

Productivity

The range productivity of forest ecosystems should be evaluated by some system that integrates all of the outputs, but we cannot yet achieve such a holistic ideal. We are compelled to accept the Forest Survey system for estimating productivity based on capacity to produce cubic volumes of wood. The corresponding categories for estimating the productivity of an acre of forest ecosystem are:

Forest Survey Site Class	FRES Productivity
120 or more cubic feet	High
85 thru 119 cubic feet	Moderately high
50 thru 84 cubic feet	Moderately low
00 thru 49 cubic feet	Low

Commercial forest types that produce less than 20 cubic feet are classified by the Forest Survey as noncommercial unproductive. FRES will consider forest lands in this category as being of low productivity.

Productivity of forest ecosystems can be described quite precisely in terms of volume of wood produced, but the physical and biological factors related to productivity can only be described in generalities. It is impossible to describe for forest ecosystems the myriad factors that affect productivity directly or indirectly. Forest ecologists now lean toward describing site production potential in terms of moisture relations. Generally mesophytic sites have the highest productivity, and productivity falls off when too much or too little moisture is available. Most of the characteristics associated with forest site productivity are related to this concept of moisture availability:

Character	High Productivity	vs.	Low Productivity
Soil			
depth	deep		shallow
texture	friable or light		sandy or heavy
permeability	permeable		impermeable
nutrients	fertile		infertile
moisture	optimum		very dry or wet
drainage	well drained		bog or swamp
Slope			
position	bottomlands and lower slopes		ridgetops and upper slopes
aspect	north and east facing		south and west facing
Growing season	long		short
Lesser vegetation	luxuriant		sparse

Experts, knowledgeable about the management and ecology of a specific forest ecosystem, can point to the environmental factors most closely related to production of wood, lesser vegetation, and other outputs.

Condition Classes

Three condition classes unrelated to those used for range productivity will be recognized for each forest ecosystem. Nonstocked stands will be considered as being in condition 1. Seedling-sapling and pole stands will be considered as being in condition 2. Sawtimber stands will be considered as being in condition 3. This system is arbitrary for it overlooks stocking level. But we must accept it for Forest Survey cannot provide any better single procedure for evaluating condition.

Condition 1 would be found on areas that are not stocked with trees. Nonstocked areas, according to Forest Survey, have less than 10 percent of the area occupied by growing stock of forest trees. The nonstocked condition may be ephemeral, as in the hiatus between crops of forest trees, or it may be relatively permanent, such as brush-covered lands resulting from past forest fires. Nonstocked land is classified according to its estimated productivity for timber, but the forest type or FRES ecosystem is not given by Forest Survey. Therefore, acreages of nonstocked forest land in a State are or will be available by ownership and productivity class. FRES will prorate the nonstocked areas to the forest ecosystems occurring in each ownership in a State.

Outputs from nonstocked forest ecosystems will be characterized in general by: abundant herbage and browse production, maximum yields of water, greater storm runoff and sediment production, some reduction in water quality, and increased diversity and abundance of all species of wildlife. Wood production on sites of low productivity probably would only average 5 percent of the yields on stands in good condition. However, on sites of fairly high to high productivity wood yields might average 25 to 40 percent of stands in good condition.

Nonstocked forest ecosystems would require comparatively little cost to put them under a range management strategy that would achieve maximum range outputs. This is in contrast to the relatively great cost required to restore timber production potentials of nonstocked forest lands.

Condition 2 stands with seedlings and saplings or poles will have trees up to about 9 inches in diameter, or 11 inches in the Far West.

Condition 3 stands with sawlogs will have at least 50 percent of the trees above 9 or 11 inches in diameter.

FRES

ECOSYSTEMS

NO. 10 - WHITE-RED-JACK PINE

Physiography - This ecosystem occurs generally on smooth to irregular plains and tablelands. More than 50 percent of the area is gently sloping. Local relief is often 100-300 feet. A small portion of this ecosystem occurs on the low mountains of the Appalachian Range where relief is 1000-3000 feet, and less than 20 percent of the area is gently sloping.

Climate - Average annual precipitation is 25-45 inches, distributed rather evenly throughout the year. Normal pan evaporation is 30-35 inches. During the 120-140 day frost-free season precipitation is roughly equal to evaporation.

Vegetation - Forest in which 50 percent or more of the stand is eastern white pine, red pine, or jack pine, singly or in combination, represents the white-red-jack pine ecosystem. Common associates include oaks, eastern hemlock, aspen, birch, northern white cedar, and maple. Much of this ecosystem is included in Kuchler's (1966) Great Lakes pine forest (86) and northern hardwoods (97).

Fauna - The white-tailed deer and black bear are the most common larger mammals in this ecosystem, with the moose inhabiting the extreme northern portion. The woodland caribou formerly was abundant. In times past the eastern timber wolf was very numerous and fed on small animals and the larger mammals listed above, but today the wolf is very scarce and is classified as an endangered species. The coyote, bobcat, great horned owl, and hawks are among current predators. The snowshoe rabbit and other small forest mammals are the main food source of the above predators. Spruce and ruffed grouse inhabit the ecosystem. Porcupines may inhabit parts of the ecosystem and become a problem in forest management when they are overly abundant. Breeding bird populations average about 153 pairs per 100 acres. The blackburnian and black-throated green warblers are the most abundant. The other species include whip-poor-will, crested flycatcher, wood pewee, white-breasted nuthatch, veery, tanagers, ruffed grouse, great horned owl, pileated woodpecker, hairy woodpecker, downy woodpecker, bluejay, chickadees, red-eyed vireo, black and white warbler, oven-bird, redstart, black-throated blue warbler, hermit thrush, magnolia warbler, Canada warbler, yellow-bellied sap-sucker, olive-sided flycatcher, red-breasted nuthatch, brown creeper, winter wren, blue-headed vireo, myrtle warbler, slate-colored junco, and white-throated sparrow. The endangered Kirtland's warbler occurs in limited areas.

Soils - The cool moist soils associated with this ecosystem are predominantly Spodosols. They have a low base supply and a horizon in which organic matter plus compounds of iron and aluminum have accumulated, but they have no dense, brittle, or indurated horizon (Haplorthods).

Soils of a significant proportion of the total area of the ecosystem are moist throughout the year, coarse textured, and lack pedogenic horizons (Udipsamments).

Land use - Nearly all of the land is forested, and lumbering and recreation are the principal uses. The associated cropland is devoted largely to potatoes and forage for dairy cattle. Large urban areas characterize the northeastern portions.

NO. 11 - SPRUCE-FIR

Physiography - This ecosystem occurs on flat plains and tableland in the Lake and New England States and at high elevations in the Appalachian Mountains. Apart from the high elevation stands local relief (exclusive of Alaska) is almost entirely less than 500 feet and often less than 100 feet. Well over one-half of the area is gently sloping. Physiographical features at the Alaska portion are more varied.

Climate - Normal annual precipitation is 30-40 inches, half of which falls during the 120-140 day frost-free season. Normal annual evaporation is 30-40 inches. Evaporation is about equal to precipitation during the frost-free season. (Climate information on the Alaska portion not available at time of typing.)

Vegetation - Forests in which 50 percent or more of the stand is spruce or true firs, singly or in combination, characterize this ecosystem. Common associates include northern white cedar, tamarack, maple, birch, and eastern hemlock.

Fauna - The fauna of the spruce-fir ecosystem is similar to that described for other northern conifer regions. A list of mammalian species from Mount Katahdin, Maine, includes moose, woodland caribou, lynx, marten, black bear, long-tailed weasel, white-footed mouse, and other mice and shrews. The moose, black bear, and white-tailed deer are the more common larger animals in the conifer region. The spruce-fir ecosystems occur as far south at higher elevations as West Virginia. The ruffed grouse is common throughout. The wild turkey may be found toward the south; the spruce grouse is found more to the north. The eastern timber wolf is considered an endangered species. Characteristic breeding birds of the ecosystem in the northeastern States are the olive-backed thrush, magnolia warbler, Cape May warbler, myrtle warbler, bay-breasted warbler, and white-throated sparrow. Density of territorial males may be as high as 430 per 100 acres. The Alaskan portion lies mainly in the interior and is interspersed with tundra, etc., and species for the two often cannot be easily separated. Larger mammals include the moose, mountain sheep, mountain goat, black bear, brown bear, caribou, wolves, grizzly, wolverine, etc. Some species perhaps more typical of the tundra that occupy the ecosystem, at least seasonally, are the rock ptarmagin, willow ptarmagin, arctic fox, collared pika, hoary marmot, arctic hare, etc.

Soils - The cool**moist** soils of this ecosystem are predominantly Spodosols, although a large acreage of Histosols occurs in the Lake States and Alaska. The Ipodosols have a low base supply and a horizon in which organic matter plus iron and aluminum compounds have accumulated. No dense, brittle, or indurated horizon is present (Haplorthods). The Histosols are wet, organic (peat and muck) soils.

Land use - In the northeastern States much of the area is forested. Lumbering and recreation are major uses of the forest. About 10 percent of the area is in crops or pastures. Most of the cropland is in forage crops for dairy cattle. Farming is a part-time enterprise, and most occupants earn their living from non-farm occupations.

NO. 12 - LONGLEAF-SLASHPINE

Physiography - The ecosystem is restricted to flat and irregular southern Gulf Coastal Plains. Well over 50 percent of the area is gently sloping. Local relief is less than 300 feet. The southern Gulf Coastal Plains are a grouping of various plains of sandy or gravelly materials to moderately fine textured materials developed from the underlying materials of unconsolidated sands, silts, and clays. This ecosystem is often referred to as the "Southern Pine Hills," the "Piny-woods," or "pine-wiregrass type."

Climate - The longleaf-slashpine ecosystem occurs in a relatively moist warm climate with an average annual precipitation of 40-60 inches. Average annual evaporation is 42-48 inches. The average precipitation is lowest in autumn and highest in midsummer in the east and in winter and spring in the west. Summer droughts are common in spite of the high precipitation and relatively low evaporation. Mean annual temperature is 64°F. and average frost-free period is 200-280 days, increasing from north to south.

Vegetation - Forests in which 50 percent or more of the stand is longleaf pine or slashpine, singly or in combination, characterize this ecosystem. Common associates include other southern pines, oak, and gum.

On most sites grasses either dominate the understory or share dominance with shrubby forms. East of the Apalachicola River wiregrass is the main herbaceous species, whereas bluestems provide most of the herbage in the western section. Other important grasses include panicums, paspalums, and dropseeds, Gallberry, saw-palmetto, wax-myrtle, and shining sumac are prominent among the shrubs.

Fauna - Longleaf- slash pine forests provide habitat for a wide variety of animal life. Except for a few isolated areas, where the Black bear or the endangered Florida panther may rarely be encountered, the white-tailed deer is the only large, indigenous mammal. Common small mammals include raccoon, opossum, tree squirrels, rabbits, and numerous species of ground-dwelling rodents. The bob-white quail and the wild turkey are the principal gallinaceous game birds. Resident and migratory non-game bird species are numerous, as are the species of migratory water-fowl. The red-cockaded woodpecker is an endangered species. Reptiles include a wide array of species, with the endangered American alligator being the largest.

Soils - Longleaf-slash pine vegetation occurs on a wide variety of upland soils, but most are acid in reaction, low in organic matter, and deficient in the major plant nutrients. Soils are derived mainly from Coastal Plain sediments, ranging from heavy clay to gravel,but with sandy materials predominating. Silty soils occur mainly on expansive level areas. Although sands are most prevalent in hilly sections, they occur on broad

flats in central Florida. Sandy soils having a dense, though not impermeable, subsoil are apparently most favorable to longleaf pine. Soils are mainly of three orders: (1) those low in bases and having subsurface horizons of clay accumulation; they are usually moist, but during the warm season some are dry part of the time (Ultisols); (2) those with low base supply and having in subsurface horizons an accumulation of amorphous materials consisting of organic matter plus compounds of aluminum and usually iron; formed in acid, mainly coarse-textured materials (Spodosols); and (3) those having no pedogenic horizons (Entisols). Hapludults, Haplaquods, and Quartzipsamments comprise the principal great soil groups.

Land use - Portions of the area are nearly all in farms; others are owned largely by pulp and paper mills. In general, half to nearly all is forest, and the trend is to more pasture and forest and less cropland. In southern Florida only about one-fourth of the area is in forest, and the forest is grazed extensively. About one-half of the area is in pasture, and the trend is to more improved pasture.

NO. 13 - LOBLOLLY-SHORTLEAF PINE

Physiography - This ecosystem is generally found on irregular Gulf Coastal Plains and the Piedmont where 50-80 percent of the area is gently sloping. Local relief is 100-600 feet on the Gulf Coastal Plains to 300-1000 feet on the Piedmont. About 20 percent of the ecosystem occurs on the flat coastal plains where more than 80 percent of the area is gently sloping and local relief is less than 100 feet. This is the largest ecosystem in the south-southeast.

Climate - The soil parent material differs considerably between locations, but the climate is very similar. Average annual precipitation is 40-60 inches. It is rather evenly distributed through the year with a slight peak in midsummer or early spring in the west. Precipitation exceeds evaporation, but summer droughts still occur. Average annual temperature is 60°-68°F. with an average frost-free period of 200-280 days (250 days in Piedmont).

Vegetation - This ecosystem is characterized by forests in which 50 percent or more of the stand is loblolly pine, shortleaf pine, or other southern yellow pines, singly or in combination. Common associates include oaks, hickory, sweet gum, black gum, red maple, and winged elm. The main grasses are bluestems, panicums, and longleaf uniola. Dogwood, viburnums, haws, blueberries, American beautyberry, yaupon, and numerous woody vines are common in the understory. This ecosystem corresponds closely to Kuchler's (1966) oak-hickory-pine forest, with the main difference being the inclusion of the oak-pine type in Kuchler's description. This ecosystem is also referred to as the shortleaf-loblolly pine-bluestem type with range-livestock production combined with timber production.

Fauna - The fauna of the loblolly-shortleaf pine forest varies with the age and stocking of the timber stand, percentage of deciduous trees, and proximity to openings, bottomland forest types, etc. The white-tailed deer is widespread, as are the eastern wild turkey, bob-white quail, mourning dove, and cottontail. When deciduous trees are present, the fox squirrel is common on uplands. Gray squirrels are found along intersecting drainages. Raccoon and fox are found throughout the type and are hunted in many areas. In mature forests the breeding bird density is about 240 pairs per 100 acres. Of the 20 odd species present the most common include the pine warbler, cardinal, summer tanager, Carolina wren, ruby-throated hummingbird, bluejay, hooded warbler, eastern towhee, and tufted titmouse. The red-cockaded woodpecker is an endangered species.

Soils - Typical soils are low in bases and have subsurface horizons of clay accumulation. The clay horizon may be relatively thin (Hapludults) or thick (Paleudults). They are usually moist, but during the warm season

some are dry part of the time. Near the coast the soils are seasonally wet and have mottles, iron-manganese concentrations, or gray colors (Aquults). The Gulf Coastal Plains are underlain by unconsolidated sands, silts, and clays, while the Piedmont is a dissected plateau underlain by schists, gneisses, granites, sandstones, and shales.

Land use - About 60-70 percent of the area is in forest, mostly in farm woodlots, but a few large areas are in National Forests or managed by large lumber companies. About 20 percent of the area is in cropland, and cash crops are produced. The trend recently has been toward more pasture and woodland and less cropland.

NO. 14 - OAK-PINE

Physiography - This ecosystem occurs on diverse land forms from the southernmost ridges and valleys of the Appalachians westward across the Coastal Plains and up into the Ozark-Ouachita Mountains. Typically it occupies irregular plateaus where 50-80 percent of the area is gently sloping and local relief is 100-300 feet. Almost equally common are hills and mountains where gentle slopes may cover as little as 20 percent of the area and local relief may reach 1,000-3,000 feet.

Climate - The oak-pine ecosystem is widely scattered over the southern Appalachian ridges and valleys to the Ozarks. However, the climate is quite similar;i.e., relatively high average annual precipitation--40-54 inches, most coming late autumn and spring with dry summers. Average annual temperature varies 55°-68°F. and average freeze-free period is 180-220 days.

Vegetation - Forests in which 50 percent or more of the stand is hardwoods, usually upland oaks, but in which southern pines, mainly shortleaf pine, make up 25-49 percent of the stand characterize this ecosystem. Common associates include gum, hickory, and yellow-poplar. Productivity of the understory is relatively low, ranging from 50 to 500 pounds of herbage per acre per year. This ecosystem includes portions of Kuchler's (1966) blackbelt, mixed mesophytic forest, Appalachian oak forest, and oak-hickory-pine forest.

Fauna - Fauna of oak-pine type is similar to that of the adjacent oak-hickory type. The white-tailed deer, fox squirrel, and cottontail are among the game animals, and mourning doves, bobwhite, and turkey are game birds. A number of small mammals are present, and the avian fauna is quite varied.

Soils - The most typical soil is low in bases and has a subsurface horizon of clay accumulation that ranges from relatively thin (Hapludents) to thick (Paledults). They are usually moist but may become dry during part of the dry season. The soils of the Ozarks are developed from cherty limestone while those of the southern Appalachians are from non-cherty limestone.

Land use - Most of the land area is in farms. About 60 percent is forest, mostly in small holdings. Twenty percent is cropland. This is a cash-crop area. Less than 10 percent is in pasture. Much of the livestock produced is consumed on the home farm.

NO. 15 - OAK-HICKORY

Physiography - The oak-hickory ecosystem occurs on the mesophytic (more mesophytic than surrounding areas) areas known as the Ozark-Boston Mountain Plateaus with extensions (cross-timbers) into the semiarid grasslands of the southern great plains and the interior low plateaus which fuse with the glacial till plains south of the Great Lakes and extend westward around the Ozark-Boston Mountains (immediately west of central Appalachian Highlands). This ecosystem also occurs on the uppermost limits of the Appalachian Highlands known as the Blue Ridge and Valley and Ridge provinces of these highlands. These areas are geologically the oldest uplifts in the United States.

The Ozark-Boston Mountain plateaus and their extensions comprise an area of 72,000 square miles west of the Mississippi River and south of the Missouri and consist of plateaus variously dissected and of strong rock, and much of it is steep with altitudes of 1,000 to 2,000 feet. Physiographically similar areas (narrow belts) extend as far south as Texas and New Orleans and along streams north into Iowa. The interior low plateaus and their extensions lie east and north and extend westward around the Ozark-Boston Mountain plateaus. These plateaus are similar to the Appalachian provinces in that the rocks and soils are highly weathered. The extensions are more characteristically glacial till plains.

The Blue Ridge and Valley and Ridge provinces are Appalachian Mountain belts west of the Piedmont. The mountains are remnants of a former highland. Most of the rocks are old, strong, and of highly complex structure. These provinces are folded mountains in which resistant strata form ridges and weaker rocks are worn down to lowlands.

The blackbelt, also characteristic of this oak-hickory ecosystem, is the richest and best known lowland in the East Gulf Coastal Plain. It is so named because of the deep black residual soil formed over selma chalk (ratten limestone). The belt varies from 20 to 25 miles wide from near the Georgia border west through Alabama north through Mississippi. Its altitude varies from 200 to 400 feet. Large streams (rivers) cut through the belt while smaller streams are few.

Climate - Temperatures vary considerably in the far flung oak-hickory ecosystem; the frost-free season is about 120 days in the northern portion and almost 300 days in south Texas. For most of the area the frost-free season is in the 160-200-day range. Annual precipitation ranges from less than 30 to more than 50 inches; the ecosystem averages 35-45 inches, more than half of which falls in the warm season. In many areas the warm season evaporation is about equal to the precipitation.

Vegetation - Four major vegetation types characterize the oak-hickory ecosystem; they are the sweetgum-oak-juniper type on the blackbelt on the Coastal Plain in Alabama and Mississippi, the oak-hickory and oak-hickory-bluestem types of the Ozark-Boston Mountains and interior low plateaus and their extensions, and the oak forest of the Appalachians. The major life form is a tree synusia varying from open to closed woods with a strong to weak understory of shrubs, vines, and herbaceous plants. Oak and hickory must make up 50 percent of the stand, singly or in combination, to make it an oak-hickory ecosystem. However, if southern pines make up 25-49 percent of the stand, it is then an oak-pine ecosystem. Sweetgum and redcedar are close associates in the southern (blackbelt) region of the oak-hickory ecosystem. Maple, elm, yellow poplar, and black walnut often are close associates in eastern and northern parts of the oak forest and oak-hickory-bluestem types. The major shrub species are blueberry, viburnum, dogwood, Rhododendron spp., and sumac. The major vine species are woodbine, grape, poison ivy, greenbrier, and blackberry. Important herbaceous plants are sedges, panicums, bluestem, lespedeza, tickclovers, goldenrod, pussytoes, Aster, and many more which can be locally abundant.

Fauna - The fauna of the oak-hickory ecosystem is similar to other eastern hardwood and hardwood-conifer areas and varies somewhat from north to south. Important animals in the ecosystem are the white-tailed deer, black bear, bobcat, gray fox, raccoon, gray and fox squirrels, eastern chipmunk, white-footed mouse, pine vole, short-tailed shrew, cotton mouse, etc. Bird populations are large. The turkey, ruffed grouse, bobwhite, and mourning dove are game birds in various parts of the ecosystem. Breeding bird populations average about 225 pairs per 100 acres, involving some 24-25 species. The most abundant breeding birds include the cardinal, tufted titmouse, wood thrush, summer tanager, red-eyed vireo, blue-gray gnatcatcher, hooded warbler, and Carolina wren. The box turtle, common garter snake, and timber rattlesnake are characteristic reptiles.

Soils - This ecosystem reaches from southern Maine to Lake Huron and to south Texas; soils are naturally quite varied. In the northeastern oak-pine forest and northeastern portion of the Appalachian oak forest, soils are mainly Spodosols. Most of the Appalachian oak forest is on Inceptisols and Ultisols. Soils of the smaller blackbelt area are in a large part areas of Ultisols. The largest type in the ecosystem, the oak-hickory forest, is made up of mainly Mollisols and Alfisols in the north and Ultisols in the central portion. Two "fingers" of oak-hickory reaching into south Texas coincide with areas of Alfisols with Vertisols on all sides in other ecosystems.

Land use - Small general farms characterize much of the area, but there are also large dairy and livestock farms present. Tobacco is an important cash crop in the east, cotton in the west. The steeper slopes, almost half the area, are mainly in forest which are used for both recreation and timber production. A large part of the Nation's coal is mined in this system.

Productivity Classes

Herbage and browse production of this ecosystem varies drastically (200 to 3000 pounds per acre) due to variation in capabilities of sites and also hardwood crown cover. The herbage figures herein include only those yields achieved in natural cover and do not include yields achieved when low-grade oak-hickory forests are converted to grasslands. This could be logically another productivity class with yields ranging from 3000 to 6000 pounds per acre.

Class 1 (75-100 Percent) - The vegetation of the oak-hickory-bluestem type occurring on the Cross Timbers and the glacial till area south of the Great Lakes characterizes the highest productivity class of this ecosystem. This type is characteristically a transition zone between hardwood forest and prairie biomes. Herbage yield varies from 3000 to 6000 pounds per acre with average of about 4500 pounds per acre. The major tree species are mainly oak and hickory with maple, oak, and elm more common in northern parts. The major grass species are those associated with the tall grass prairie; namely, big and little bluestem, Indian grass, switchgrass, and sideoats grama. Forb composition is rich.

The soils are highly variable but are mainly Mollisols (Agiudolls soils that have a subsurface horizon in which clay has accumulated) in the northern part and Alfisols (Paleustolfs plus Ustrotents which also have a subsurface horizon in which clay has accumulated in the southern Cross Timber area). Large areas of Inceptisols (Ustockrepts, shallow soils, 20 inches to bedrock) also occur in the southern part (Cross Timbers). About 25 percent of the northern oak-hickory-bluestem type now exists as tame or native pasture and 10 percent as woodland. The remainder is in cash crops. About 50 percent of the southern part of this vegetation type (Cross Timbers) now exists as rangeland and open woodland; the remainder is in small grains and other cash crops.

Class 2 (50-75 Percent) - The vegetation that would characterize the next highest production class of this ecosystem would be that of the blackbelt with yield ranging from 1500 to 3000 pounds per acre. This figure includes browse as well as herbage. The vegetation of this area is highly variable, ranging from almost open bluestem prairie to dense forest of tall or medium broadleaf deciduous trees with sporadic (on calcareous rock outcrops) concentrations of redcedar. The major herbage plants are big and little bluestem, switchgrass, Indian grass, and a mixture of forbs, deciduous trees. Most common are sweetgum, post oak, and other oaks and hickories. Low growing trees and shrubs are winged elm, ash, dogwood, and many others. The soils are variable and include Vertisols (Chromuderts plus Entrochrepts, gently sloping, and clayey), Inceptisols (Eutrokrepts plus Chromuderts, gently sloping, usually moist and high in bases), and Ultisols (Paleudults, moderately sloping and have a thick horizon of clay accumulation and are low in bases, plus Gragiudults, gently sloping, which have a fragipan).
Most of the blackbelt is now in farms, with one-fifth cropland, two-fifths in forests, and the remainder in pastures and urban uses.

Class 3 (25-50 Percent)- The open meadows of the oak and oak-hickory forests of the Smoky Mountains in the Appalachians and the Ozark-Boston Mountains, with herbage production ranging 1200 to 1800 pounds per acre, with an average of about 1500 pounds, characterize this productivity class. The major herbaceous species are the bluestems, poverty oat-grass, panic grass, and three awns. Forbs are less common. Blackberry, sassafras, and persimmon are the major browse species.

The soils are Ultisols (Paleudults plus Fragiudults) and Inceptisols (Dystrochrepts plus Fragiochrepts) which are soils with fragipans restricting tree roots but which support low growing plants.

These areas are usually small in acreage and are now mainly used for forage production (pasture or hay).

Class 4 (0-25 Percent) - The vegetation within the forest proper (excluding open meadows) of the Appalachian oak forest and the oak-hickory type of Ozark-Boston Mountain plateaus characterize this productivity class. The vegetation types and yields vary considerably and will be described separately. Herbage and browse production (mainly browse) varies from 500-800 pounds per acre (average of 650 pounds per acre). The major tree species are white oak, northern red oak, and white ash as a whole with associates of red maple, yellow birch, aspen, black cherry, and butternut in the northern parts and with associates of yellow buckeye, yellow birch, sugar maple, and black cherry in the mid and southern parts. White ash becomes of less importance or is absent in the southern part. The major species of the shrub strata are vicburnum, sassafras, mountain laurel, rhododendron, Madrone, blueberry, blackberry, sedges, sorrel, cinquefoil, fern genera, and clubmoss.

The soils are mainly Ultisols (Hapludults plus Dystrochrepts and Paleudults) in the southern part and Inceptisols (Dystrochrepts) and Spodosols (Haplorthods plus Haplaquepts and Fragiochrepts) in the north. All vary from moderately to steeply sloping.

About half the area is now in forest or farm woodlots and one-fourth to one-third is in cropland and pasture, with cropland and pasture more prevalent in the northern parts.

The oak-hickory vegetation type of the Ozark-Boston Mountain plateau and the interior low plateaus characterizes vegetation with herbage and browse (combined) yields of 200 to 300 pounds per acre. The major tree species are oaks -- black, red, white, post, and blackjack, hickories -- black, bitternut, and shagbark, and elm. The major shrub species are blueberry, wild grape, blackberry, poison ivy, woodbine, greenbriar, and dogwood. Herbaceous plants include sedges, panicums, tickclovers, goldenrod, pussytoes, and Aster.

The soils are mainly Ultisols (Hapludults plus Hapludolfs and Paleudults, moderately sloping to steep). Some are Ultisols with a fragipan (Fragiudults).

About three-fifths of this area is now forest or woodland with the other two-fifths divided into cropland and pasture. The conversion of forest land to grassland has become increasingly common in this area.

NO. 16 - OAK-GUM-CYPRESS

Physiography - This ecosystem is characterized by the vegetation of the Mississippi Valley and other bottomlands in every Southern State, the Cypress savanna west of the Everglades in Florida, the Mangroves south of the Everglades, and the east coast of Florida, Georgia, and Carolinas. The floodplains of many of the rivers that cross the Coastal Plain province have little drop in elevation (Mississippi drops 7.5 inches per mile from Memphis to Vicksburg) and do considerable meandering. This has created large alluvial plains. The largest are on the Mississippi River and extend from the Gulf of Mexico to Ozark-Ouachita highlands and northeastward up to Indiana. Other river floodplains are much smaller but in aggregate constitute several million acres.

The alternating dry and wet lands west of the Everglades are known as the "Cypress savanna." It is a monotonous flatland a very few feet above sea level. Outcrops of dense, fine-grained limestone occur scattered through the area, but these do not affect the flatness of the plain. The mangrove swamp of southern Florida is an extension of the Everglades into the ocean. Salt water invades that part of the coastline which makes it different from the Everglades or cypress savanna.

Climate - Most of this ecosystem has a moist mild climate with a frost-free season of 200 days to practically all year at the tip of Florida. Precipitation ranges from 60 inches in Florida to about 35 at the northern extremity in Indiana. More than half the precipitation comes in the warm season, and in most of the area rainfall exceeds evaporation during the frost-free season.

Vegetation - The vegetation of this ecosystem varies considerably but the dominants are of tree life-form. It is made up of bottomland forests in which 50 percent or more of the stand is tupelo, black gum, sweetgum, oaks, and bald cypress, singly or in combination, except where pines comprise 25-49 percent, in which case the ecosystem would be classified as oak-pine. Common associates include willow, maple, sycamore, cottonwood, and beech. Most species are broadleaf deciduous trees. Trees of the mangrove swamp are mainly black and red mangrove. The vegetation of the cypress savanna is dominated by needleleaf deciduous trees and some broadleaf evergreen or deciduous trees and shrubs. The trees and shrubs occur in groves surrounded by open grassland dominated mainly by three awn species. Mangrove swamps are often flooded by tide (salt) water while the cypress savanna is flooded less frequently and only by fresh water.

Fauna - This ecosystem is the most fertile and productive of southern habitats for wildlife. In times past, larger animals such as deer, elk, black bear, mountain lion, bobcat, and wolves used the forest. Presently,

the white-tailed deer is common in most areas. Other mammals include the gray fox, gray and fox squirrels, raccoon, opossum, striped skunk, eastern cottontail, swamp rabbit, and many small rodents and shrews. Birds include the wild turkey and in the flooded areas birds such as ibises, cormorants, herons, egrets, and kingfishers. Among the numerous species of birds in the area, the ivory-billed woodpecker, Bachman's warbler, and southern bald eagle are classed as endangered species. The Carolina parakeet is extinct. Many species occurring in the mangrove and cypress savanna are the same as those in the Everglades, discussed under the Wet Grasslands ecosystem. More common mammals in the mangrove area are the fox squirrel and raccoon. Nesting birds include the mangrove cuckoo and various herons and egrets. The key deer is now very scarce and is classed as an endangered species.

Soils - Soils of this ecosystem are varied. The largest area, the Mississippi bottomland, is made up of some Mollisol and Alfisol but is primarily Inceptisol as is the small area in southern Florida. In the many bottomlands extending inland from the Atlantic Coast the soils are mainly Ultisols with smaller areas of Inceptisol near the coast.

Land use - Nearly all of the area is in farms. The wettest areas that are not artificially drained remain in forests, about 10 percent of the area. The remainder is evenly divided between cropland and pasture. Cotton, soybeans, and corn are major crops in most of the region; rice and sugarcane are locally important.

NO. 17 - ELM-ASH-COTTONWOOD

Physiography - The major portion of this ecosystem occurs on the lower terraces and floodplains of the Mississippi-Missouri-Platte-Kansas-Ohio Rivers from the Dakotas, Minnesota, and Ohio south through Kansas and Missouri. It also occurs scattered throughout the states adjacent to the Great Lakes to the east coast where it occurs on dissected glacial-till plains.

Climate - This ecosystem, occurring as narrow belts along major streams or scattered areas of dry swamps, extends throughout the North Central and Lake States, crossing several climatic zones. However, it is characteristic of moist sites either by flooding or precipitation. Annual average precipitation varies from 10 inches near the foothills of the Rocky Mountains to 50 inches in the southern and northeastern areas. Temperatures vary considerably also with January mean daily low of zero in the north to 30° F. in the southern part. Average frost-free period varies from 100 days in the north to 200 days in the south.

Vegetation - The vegetation of this ecosystem is a tree-life form of low to tall broadleaf deciduous trees, open to dense often with vines. Cottonwood species usually dominate and often in pure stands. Cottonwood is the most common along the streams and swamp cottonwood more common other places. Common associates in the northern region are willow species and green and white ash while sycamore and sugarberry are common associates in the southern region. According to Forest Survey definition, a forest becomes this type when 50 percent or more of the stand is elm, ash, or cottonwood, singly or in combinations. Common associates can be willow, sycamore, beech, and maple. The cottonwood-willow stage is short lived and the stage passes to the river birch, silver maple-American elm types in the north and to the sycamore-pecan-American elm or sugarberry-American elm-green ash types in the southern part of this ecosystem.

Fauna - Since this type is rather far-flung and is in the main floodplains of various rivers dissecting a number of other quite different ecosystems, the fauna is varied and in many cases influent from the surrounding ecosystems. Forest edge animals and birds are common in the elm-ash-cottonwood; some of the more numerous include the cottontail, bobwhite, white-tailed deer, raccoon, red fox, coyote, striped skunk, spotted skunk, meadow jumping mouse, ground squirrels, and fox squirrel. The sharp-tailed grouse inhabits open areas in forest and grassy areas, and the ruffed grouse also is in the ecosystem. Other birds include the catbird, goldfinch, yellow-billed cuckoo, indigo bunting, cardinal, lark sparrow, mockingbird, common crow, robin, ruby-throated hummingbird, and Cooper's hawk.

Soils - Soils are classified as mainly Mollisols (Haplaquolls plus Udifluvents, Hapludolls, and Hapludolfs) which are seasonally wet and have a thick, nearly black surface horizon and gray subsurface horizons. The materials in the horizons have been altered or removed, but no clay or calcium carbonate has accumulated.

Land use - At least 30 percent of this ecosystem is in forest, mainly as small woodlots on wet bottomland and steep slopes bordering stream valleys. The remainder is cropland devoted primarily to corn, soybeans, oats, and other feed grains. Much of the grain is fed to beef cattle and hogs on the farms where it is grown.

NO. 18 - MAPLE-BEECH-BIRCH

Physiography - The maple-beech-birch ecosystem is best developed in the New England States. Typically, it occurs on open high hills and low mountains. Only about 20-30 percent of the area is gently sloping. Ridges rise 500 to 3,000 feet above the broad valleys. Farther west in the Lake States the ecosystem occurs on irregular plains and tablelands where 50-80 percent of the area is gently sloping and local relief is normally 100-300 feet.

Climate - Mean annual precipitation ranges from 40-48 inches but is about 41 inches at central locations. The annual snowfall of 72 inches covers the ground for about 87 days each year. The number of freeze-free days ranges from 120-150 per year. Mean daily maximum temperature is 24°-36°F. in January, 74°-80°F. in July. The corresponding minimum temperatures are 4°-18°F. and 52°-60°F. Potential evapotranspiration is 17-28 inches; mean annual water surplus is 10-34 inches.

Vegetation - A forest is classified (according to Forest Survey definitions) as this ecosystem when 50 percent or more of the stand is maple, beech, or yellow birch, singly or in combination. Common associates include hemlock, elm, basswood, and white pine.

Fauna - The white-tailed deer occurs throughout much of the maple-beech-birch type. The hardwood forest and the openings and farms within it provide food and cover for a varied fauna. The black bear is present in many areas. Wolves are no longer common, but the red fox and gray fox are rather widespread as is the bobcat. Several species of squirrels are in the forest and a number of smaller rodents inhabit the forest floor. The ruffed grouse is widespread, and the bobwhite inhabits the interspersed farmlands and forest openings. Songbirds include the ovenbird, red-eyed vireo, hermit thrush, scarlet tanager, bluejay, black-capped chickadee, wood pewee, magnolia warbler, and many others.

Soils - Typical soils have a low base supply and a subsurface horizon that is dense, brittle, but not indurated, or contains an accumulation of organic matter plus iron and aluminum compounds (Fragiorthods and Haplorthods). A second major soil type has light-colored surface horizons and a subsurface horizon that is dense, brittle, but not indurated (Fragiochrepts).

Land use - Much of the area is in farms. Feed grains and forage for dairy cattle are the principal crops. Potatoes are important locally. The steeper land is mainly forested, produces significant amounts of timber, and is an important recreation resource.

NO. 19 - ASPEN-BIRCH

Physiography - The aspen-birch ecosystem lies mainly within the Great Lakes section of the central lowlands east of the Mississippi. This area is characterized by a great variety of features of recent glacial origin. Thousands of lakes and large areas of swamps in addition to moraines and outwash plains are present in the area. The underlying strata of the area is buried by thousands of feet of glacial till. These rock strata span the ages from Cambrian to Carboniferous. Three strong formations of dolomite, limestone, and sandstone form outcrops on the edges of two cuestas. The intervening weak beds do not form any particular features. Elevations vary from 600 to 1,500 feet.

Climate - The areas occupied by this ecosystem have a moist and cool climate. Frost-free days vary from 100 to 140 days. Average annual temperatures are from 35-47°F. Annual precipitation is from 30-35 inches, of which 40-66 percent falls during the warm season. Precipitation for the frost-free season ranges from about equal to 80 percent of the evaporation potential.

Vegetation - This ecosystem, as it is commercially defined, is as follows: Forest in which 50 percent or more of the stand is aspen, balsam poplar, paper birch, or gray birch, singly or in combination. Common associates include maple and balsam fir. Geographically this ecosystem is found mostly in the area of the Great Lakes from western Minnesota to Lake Erie in the United States. Aspen, however, extends from the Arctic Circle in Alaska southeastward to the Northeastern United States. Major aspen species in the Great Lakes area are bigtooth aspen and quaking aspen. Paper birch is a common associate in the ecosystem. Balsam poplar is only important along streams and swamp margins.

Fauna - The fauna of the aspen-birch type is similar to that of spruce-fir (11) and white-red-jack pine (10) types with which it is intermingled. The white-tailed deer and black bear are common. The coyote, bobcat, great horned owl, and other predators feed on a variety of smaller mammals. The ruffed grouse is present, and among the songbirds are the tufted titmouse, bluejay, hairy and down woodpeckers, wood thrush, eastern wood pewee, goldfinch, catbird, and red-eyed vireo.

Soils - The aspen-birch ecosystem is found on a wide variety of soils but mainly within three orders. The better drained soils are mostly Alfisols while the wetter, poorly drained soils are within the orders Entisols and Mollisols.

Land use - More than 80 percent of the area is in forest. Lumbering, recreation, and mining are major industries. Feed grains and forage for dairy cattle and other livestock are the main products of cropland. Potatoes are locally important.

NO. 20 - DOUGLAS-FIR

Physiography - This ecosystem consists of one of the larger blocks of western timber in that it includes much of the mountains in western Oregon and western Washington and extends well south into the north cost range of northern California. It is also a rather extensive ecosystem for there are large acreages of it in the northern Rocky Mountains and lesser scattered amounts in the Blue Mountains of Oregon, middle and southern Rocky Mountains. Elevational range is broad, going from 500 feet up into the high mountains.

Climate - Length of frost-free season is 200 days in western coastal areas, 160 in the balance of western Oregon and Washington. Over the balance of its range the frost-free season is about 80 to 120 days. Average annual precipitation is 40 to 80 inches in the extreme west and 20 to 30 inches over most of the interior portion of the type. Distribution of precipitation in the extreme west provides 50 to 60 percent of the total during the December to March period. Over the balance of the range only 25 to 40 percent of the precipitation occurs in the cold months. The amount of precipitation during the frost-free season is equal to or not less than 40 percent of the evaporation in western Oregon and western Washington. Over the balance of the Douglas-fir areas precipitation for the frost-free season is only 30 to 40 percent of the evaporation potential.

Vegetation - Commercially Douglas-fir stands are defined as those containing 50 percent or more Douglas-fir, except where redwood, sugar pine, or western white pine comprise 20 percent or more of the stand. Most common ecological descriptions for one of the largest blocks of timber in western Oregon and Washington define it as subclimax stands with the climax western hemlock-western red cedar formation. Common shrubs in the stands are of the genera maple, rockspirea, filbert, blueberry, snowberry, barberry, currant, blackberry, ninebark, rose, and spiraea. Grass or grass-like growth form is more apparent in the stands of interior states. Here, pinegrass and Carex concinnoides are present.

Fauna - Common large mammals in this biome include elk, deer, and black bear. Grizzly bear and moose are in the northern Rockies. Blue and ruffed grouse are present. Most of the northwest has hawks and owls. Mammalian predators include mountain lions and bobcats. Small mammals include mice, squirrels, marten, chipmunks, and bushy tailed woodrats. Some of the more common birds are chestnut-backed chickadee, red-breasted nuthatch, gray jay, and Stellar's jay.

Soils - In western Washington and Oregon this biome occupies soils of the orders Inceptisols and Ultisols. In the north coast area of California it is Ultisols also. In the Blue Mountains of Oregon Mollisols are involved with an overburden of very absorptive Vitrandept ash. For the northern Rockies the soils are Inceptisols (Considerable Vitrandepts), Alfisols, and Mollisols. In the middle and southern Rocky Mountains soils are of the orders Mollisols, Entisols, and Alfisols.

Land use - About 75 percent of the land area is forested and lumbering is a major industry. Less than 20 percent is in crops or improved pasture. Fruit, vegetables, and grain are the major crops. Forage and feed grains also occupy large acreages.

The high timber production of the best sites is the historic pattern of land use in this ecosystem in western Washington, Oregon, and California. Livestock use is not so well known. There are now more sheep in western Oregon and Washington than in the range flocks of the eastern part of these states. The big increase in sheep has been in farm flocks under woven wire fence in the lowlands. However, cutover lands in the hills and mountains have been converted on some private lands to seeded ranges for livestock, and with the favorable precipitation high stocking rates have been successfully achieved ($\frac{1}{2}$ to 1 acre per A.U.M.). With lack of management on the average tract of old cutover land, it usually becomes uneconomical to graze because of the invasion of bracken and brush. There are some possibilities for more and better livestock use of forest lands under serious and responsible management. Chiefly, there is the possibility for grazing recently logged lands in combination with seeded land at lower elevations (more research on this is needed in western Oregon). A relatively small number of cattle or sheep operations presently make use of recently logged-over lands; yet, there is the opportunity to start grazing patch clearcuts within two or three years after logging (as soon as new tree seedlings are established) and continue grazing for about 10 years, or when tree canopy closes. This practice of transitory range use has not been fully explored in its present form or enough research time given to determine its fullest possibilities and advantages to forestry. Grazing control of species competitive with trees might speed up tree growth as well as hold in check those species which cause the public to condemn patch cuts as mere weed patches unfit for trees or wildlife.

The land use story of this type in the Blue Mountains of Oregon and in the northern Rockies is one similar to the grazing-timber relationship of the ponderosa pine type. Jungling or brushing up is, however, more prevalent in the interior examples of Douglas-fir than in the ponderosa pine type. The pine stands are stated to be at least 60 percent jungled, whereas interior Douglas-fir stands are about 90 percent jungled. Suppression of timber growth

by over-density of trees has been slower to occur in fir than in pine because of fir's tolerance to shading; nevertheless, the impact on forage production has been to reduce it to 150 pounds per acre.

Productivity Classes. - Grazing in major portions of this type, western Washington, western Oregon, and western California, is usually just confined to patch clearcuts and the lands converted to pasture by logging and grass seeding. Under management for grass, production of 1,000 to 3,000 pounds per acre can be achieved. With no opening of the canopy, herbage is 50 to 150 pounds per acre.

No. 21 - PONDEROSA PINE

Physiography - Since ponderosa pine has a rather wide range of adaptability and can dominate some of the less mesic true forest sites, it occupies low mountains and foothills; yet, in mixtures with other species, it is found at moderate elevations. The extensive distribution of ponderosa pine and associates includes parts of 14 western States. It is the largest western forest type in the United States. Local topography can be gentle as on plateau tops and low mountains, or it can be steep as on canyon walls and faces.

Climate - Length of frost-free season is dependent largely upon the latitude and elevation of concern or interest. In general, much of the northern pine area has a 120-day frost-free period, whereas in many foothill areas and in parts of the Sierra and Gila Mountains of the Southwest it can be 240 days long. Annual precipitation is about 15 to 20 inches in the more pure pine areas, but in those combinations with other conifers at moderate elevations the precipitation can total 30 inches. In the far western sector only 25 percent of this moisture will fall in the warm season. In the northern Rocky Mountains 40-50 percent will occur in the warmer months, and in the middle to southern Rockies 66 to 75 percent will occur in the warm season. In the low elevation and southern areas precipitation of the frost-free season is only 20 percent of the evaporation potential, whereas in northern areas growing season precipitation may equal 40 percent of the evaporation potential.

Vegetation - By definition ponderosa pine forest is 50 percent or more of one of the pines, ponderosa pine, Jeffrey pine, sugar pine, limber pine, Arizona ponderosa pine, Apache pine, or Chihuahua pine. The exceptions are those situations where western white pine or sugar pine comprises 20 percent or more of the stand; then these species control the name of the forest. The impact of logging and ecological dynamics can cause some problems in maintaining good delineation of this ecosystem. The ponderosa pine unit is idealized as open and park-like with excellent ground cover of grasses, sedges, and forbs, or with an understory of shrubs of low to medium height. The shrubs, however, may vary from such highly desirable ones as antelope bitterbrush in Oregon to such undesirable ones as bearmat in the Sierra Mountains of California. The idealized open character of ponderosa pine has passed in 60 percent of the area to stagnating jungle character[1/], particularly in the Pacific Northwest.

[1/] "Stagnating jungle character" means pine stems at the rate of 2,000 to 10,000 stems per acre instead of 75 per acre. In most such cases growth rings will be 15 to 40 rings per inch instead of less than 15 rings per inch.

This is due to an ecological phenomenon that was triggered by a sequence of mismanaged grazing under open public land policy followed by low or custodial level of forest management in the early days of public land administration. This jungling trend can be reversed by management and great increases achieved in production of timber, forage, water, wildlife, and recreation.

Fauna - **In the ponderosa pine ecosystem the major mammalian influents are the mule deer, mountain lion, and coyote. Species of lesser importance include the bushy-tailed woodrat, white-footed mouse, bobcat, rock squirrel, cottontail, porcupine, mantled ground squirrel, chipmunks and the Kaibab squirrel. The rare Kaibab squirrel is unique; it is endemic to this ecosystem on Arizona's Kaibab plateau.**

Resident birds of most abundance and importance in the ponderosa pine ecosystem include: pigmy nuthatch, long-crested jay, sharp-shinned hawk, Rocky Mountain nuthatch, mountain chickadee, Cassin's purple finch, red-shafted flicker, red-backed junco, western goshawk, and western red-tailed hawk. Birds that are common during the summer include the chestnut-backed bluebird, Audubon's warbler, Natalie's sapsucker, western chipping sparrow, horned owl, and band-tailed pigeon.

Soils - The soils occupied by ponderosa pine vary tremendously with this extensively distributed forest category. Along the western edge of the Columbia plateau or east slope of the Cascade Mountains it occupies soils of the orders Mollisols, Inceptisols, Entisols, and Aridisols. In northern and eastern California, pine stands are associated with Ultisols. At the north edge of the Columbia plateau (Okanogan Highlands) and into much of the northern Rocky Mountains pine and the related types occupy Inceptisols; the balance there is largely Alfisols and Entisols. In the Blue and Wallowa Mountains of eastern Oregon pine occupies Mollisols. In the middle and southern Rocky Mountains pine and associates are on Mollisols, Aridisols, Entisols, and Alfisols. Pine of Gila Mountains is coordinated largely with Mollisols and the bits of pine in the Great Basin are, of course, on Aridisols.

Land Use - Ponderosa pine lands have been and continue to be producers of softwood highly desired for either millwork or framing. The forage supply within the type has been highly prized for summer range since such lands are usually high enough to get good precipitation and the forest soils are deep enough to store sufficient water for growing a true timber species and good ground cover. These precipitation and soil characteristics make the type productive of forage during the hot months when lower elevation range forage has dried.

Current forage production of the pine type is lagging behind its potential productivity, and its total productivity is suppressed enough to create a seasonal shortage of summer range for livestock. This shortage of summer range in some areas amounts to a 40 to 50 percent imbalance with the present capabilities of spring-fall and the winter forage resources. Presently many ranchers are forced to meet this situation by using spring-fall range also as summer range. Ranchers operating this way have to accept substantial weight losses in brood cows by fall of each year, and they have to accept about 75 to 83 percent calf crops compared to the rancher with true summer range who maintains 1,000 to 1,400-pound cows with a 90 percent calf crop.

The mountain summer range of the ponderosa and Douglas-fir ecosystems is also a prime summer range for a high proportion of the mule deer and a spring-fall range for elk. Approximately 20 to 30 percent of the herbage is reserved by land managers for big game use, but this is not to say this range is critical for big game; for these animals the critical range is the winter forage supply of low elevation shrub and bunchgrass ranges.

The jungling up or stagnating forest condition of this pine-Douglas-fir ecosystem is critical, not just for livestock but for wood, water, and recreation. It is usually computed that not less than 60 percent of the pine type in eastern Oregon and Washington is jungled to some considerable degree. Furthermore, the other mixed conifers with pine in the same States are 100 percent jungled. Thus, in just the eastern portion of these two States there are 15 million acres of stagnating forest and rangeland, i.e., an area the size of the State of West Virginia. Preliminary attack on the jungling problem has shown that progress is rather strongly related to fire control concepts and further development of slash disposal procedures.

Productivity Classes

The characteristics of soil and climate as primary limitations to growth of forage and soil cover plants are, in this forest ecosystem, largely modified or replaced at present by the strong influence of the dominating ecological monstrosities--the overly dense, growth-arrested, and sick stands of trees. Hence, logical divisions of productivity commonly have to be made at the location in question where a relationship will be found between forage production and density of tree stand.

About 500 to 600 pounds per acre of herbage is commonly produced by open mature pine with about 200 saplings per acre. In stands which have an understory of tree reproduction numbering 2,000 stems per acre, the herbage production will be only about 250 pounds per acre. At about 5,000 stems or more per acre, herbage production can be nil to 50 pounds per acre. When pure stands of ponderosa pine are thinned to approximately 75 to 100 stems per acre, then herbage production of 850 pounds per acre is obtainable. On reseeded skid trails it is possible to produce 1,000 to 2,000 pounds of herbage per acre.

Quality of herbage for livestock and game nutrition is increased by the timber stand improvement practice of thinning; that is, the nondigestible fraction of forage decreases and the carbohydrate proportion increases. Floristic composition of the herb and shrub understory in pine forests seems to vary with various factors, including the overstory. In the Northwest, grasses and sedges from such genera as Calamagrostis, Carex, Agropyron, Festuca, Muhlenbergia, Poa, Stipa, and Danthonia constitute 10 to 40 percent of the composition. Shrubs are very conspicuous in certain areas and may be of such genera as Purshia, Ceanothus, Rosa, Symphoricarpos, Holodiscus, Spirea, Salix, and Arctostaphylos. A mixture of forbs seems to be common.

Several introduced species of grasses are adapted to this type for revegetation purposes, but use of timothy and a few other aggressive species should be done with caution unless the objective of seeding is to control the natural restocking of lodgepole pine.

No. 22 - WESTERN WHITE PINE

Physiography - This ecosystem occurs in the high mountains of the northern Rocky Mountains. Less than 20 percent of the area is gently sloping, and local relief is over 3,000 feet. Elevations are mostly 4,000 to 8,000 feet.

Climate - Annual precipitation for western white pine stands is 20 to 30 inches; of this 60 to 65 percent occurs during the warmer season of the year. Precipitation during the frost-free season is 20 to 40 percent of the evaporation potential for the period. Length of frost-free period is 80 to 120 days.

Vegetation - Forests in which 20 percent or more of the stand is western white pine or sugar pine characterize this ecosystem.

Fauna - The fauna of the western white pine ecosystem is similar to that of the fir-spruce (23). The area is noted for its big game population, particularly the elk and mule deer. Smaller mammals include the snowshoe hare, long-tailed weasel, marten, various mice and shrews, coyote, bobcat, etc. The black bear is present. Birds that occur include ruffed grouse, chestnut-back chickadee, red-breasted nuthatch, Swainson's thrush, and many others.

Soils - Most of the soils either have formed in ashy materials, have low bulk density and large amounts of amorphous materials, or both. Horizons are weakly developed (Andepts).

Land Use - Heavy forests cover much of the land; croplands occupy less than 2 percent of the region. The forests are important for wildlife habitat (the area is famous for its elk hunting) and recreation as well as timber production.

No. 23 - FIR-SPRUCE

Physiography - This ecosystem lies within the Sierra-Cascade, northern, middle, and southern Rocky Mountain provinces. It is normally the highest forest zone in the mountain ranges but ranges from as low as 1,500 feet in the Northwest to as high as 12,000 feet in the southern Rocky Mountains. Much of the topography is rough and broken.

Climate - Annual precipitation ranges from somewhat less than 22 inches in the Rocky Mountains to 50-75 inches in the Sierras. In the Rockies 50-65 percent of the precipitation falls in the warm season, while in the Sierra-Cascade province only 25-40 percent falls in the warm season. Precipitation in the December-March period is 50-60 percent of the annual total in the Sierra-Cascades, 15-25 in the Rocky Mountains. Precipitation is 20 to 40 percent of the evaporation potential during the frost-free season.

Vegetation - The fir-spruce ecosystem is characterized by open to dense forest of low to tall needleleaf evergreen trees with patches of shrubby undergrowth and scattered herbs. Fifty percent or more of the stand is silver fir, subalpine fir, red fir, white fir, mountain hemlock, Engelmann spruce, or blue spruce, singly or in combination, except where western white pine comprises 20 percent or more in which case the ecosystem would be classified as white pine. Because of the dense overstory and limited understory, the commonly heavy stocked stand is not usually considered a forage resource for domestic livestock unless timber is harvested by patch clearcuts.

The usual dense stand produces almost nil to 50 pounds of herbaceous and shrub material. Patch clearcuts or burns which are rehabilitated by tree planting and grass seeding can produce 2,000 to 3,000 pounds of herbage per acre for 10 to 12 years.

Fauna - Seasonally, the fir-spruce ecosystem and in particular the interspersed openings and stream bottoms with broadleaved woody species such as aspen and willows are used by moose, elk, mule deer, and white-tailed deer. The mountain caribou originally wintered in Idaho, Washington, and Montana; a few still do. The wolverine, lynx, black bear, mountain lion, coyote, and wolf occur in the ecosystem. The grizzly bear is present, though in a fraction of its original numbers and classified as a rare species. Many of the above species use the fir-spruce ecosystem only seasonally, primarily as cover or in migratory routes. This is the case with mountain sheep and the mountain goat, which occurs more commonly in steep rocky areas. Among the birds in the ecosystem are several of the blue and spruce grouse groups, ruffed grouse, and various chickadees, nuthatches,

bluebirds, robins, jays, etc. Among the more common rodents and lagomorphs are the porcupine, beaver, snowshoe rabbit, squirrels, flying squirrels, pocket gophers, chipmunks, and various mice.

Soils - Soils are extremely variable. In the northwest Inceptisols (Cryandepts and Cryumbrepts) predominate, although Ultisols occur in the Sierra-Nevada range. Alfisols (Boralfs) are common in the Rocky Mountains, although significant areas of Entisols also occur. Deep over burdens of absorptive Vitrandept ash are very productive sites in eastern Oregon and northern Rockies.

Land Use - Heavy forests cover much of the area, and they are used for wildlife habitat, watershed, and recreation as well as lumbering. Cropland is essentially absent. Much of the area is owned by the Federal Government. Grazing by domestic livestock is generally limited to natural parks and meadows that occur within the forest matrix.

No. 24 - HEMLOCK-SITKA SPRUCE

Physiography - This forest includes part of south coastal Alaska, extends south from British Columbia along the Oregon and Washington coast ranges, and occupies part of the Washington Cascades. Elevation range is from 200 to 4,000 feet.

Climate - Length of frost-free season for that portion of the ecosystem along coastal parts of Oregon and Washington is 200 days. The northern Cascade portion has a season of about 120 days. In coastal Alaska the frost-free period is 170 days. Precipitation is about 60 to 115 inches annually in western Washington and Oregon. About 60 to 70 percent of the precipitation occurs in the months of December to March in western Oregon and Washington. The amount of precipitation in western Washington is mostly equal to double the evaporation potential. In western Oregon the ratio is 0.80.

Vegetation - This ecosystem is defined as 50 percent or more of the forest stand being in western hemlock and/or sitka spruce. Other tree species which may be present to lesser degree are Douglas-fir, grand fir, and western redcedar. Some of the most common shrubs are vine maple, red whortleberry, Cascades mahonia, California dewberry, and coast rhododendron. Usual herbs are American twinflower, hollyfern, Captis laciniata, and redwoods violet.

Fauna - The more common large mammals in this ecosystem include the elk, deer, and black bear, and moose. Blue and ruffed grouse are present. Quite a wide variety of mammals and birds occurs. In the hemlock areas of the northwest the red-tailed hawk, screech owl, pigmy owl, and great horned owl are avian predators; mammalian predators include mountain lions, bobcats, wolves, pacific marten, and western spotted skunk. Smaller animals include the deer mouse, Douglas squirrel, bushy-tailed woodrat, Townsend's chipmunk, coast mole, etc. Among the more common birds are red crossbill, chestnut-backed chickadee, red-breasted nuthatch, raven, gray jay, Stellar's jay, hermit warbler, western wood pewee, and pine siskin. For the portion of the ecosystem in Alaska, most of the species listed above for the Pacific Northwest occur but species such as the big brown or Kodiak bear, sitka mule deer, Alaskan timber wolf, and the red Douglas squirrel are characteristic of, and perhaps restricted to, the Alaskan coastal forests and islands.

Soils - Along coastal Oregon and Washington and in the northern Cascade Mountains this vegetation unit occupies soils of the order Inceptisols. In Alaska the soils are of special miscellaneous types.

Land Use - Nearly all the area is in forest. In the Pacific Northwest, most of the ecosystem is privately owned. Lumbering is the major industry. The narrow valleys and coastal plains, about 5 percent of the total area, is cleared. Hay for dairy cattle is the chief crop.

No. 25 - LARCH

Physiography - The larch ecosystem occupies the high mountains of eastern Oregon, northern Idaho, and western Montana. Less than 20 percent of the area is gently sloping. Local relief is over 3,000 feet. Larch commonly occupies the upper slopes, or northern exposures at lower elevations (Ca. 3,500 ft.).

Climate - Length of frost-free season is 120 days in Blue Mountains of eastern Oregon, and in the northern Rockies it is 80 to 120 days. Annual precipitation for the type is 20 to 30 inches in eastern Oregon and 20 to 50 inches in the northern Rockies. Of this precipitation, 40 to 50 percent will occur in the December to March period in the eastern Oregon area, and in the northern Rockies only 35 to 40 percent will occur in the cold period. The precipitation-evaporation ratios of frost-free season for these areas show that in eastern Oregon precipitation is 20 percent of the evaporation potential, and in the northern Rockies precipitation of frost-free season is 20 to 40 percent of potential evaporation.

Vegetation - Larch forests are commercially defined as those in which 50 percent or more of the stand is larch except where western white pine comprises 20 percent or more of the timber volume. Ecologically larch is considered seral to stands of grand fir and stands of Douglas-fir. This dense type produces 75 to 150 pounds of understory herbage per acre. However, where it is patch clear-cut, planted to trees, and seeded to grass, it will produce 2,000 to 3,000 pounds of herbage per acre for 10 to 15 years. Understory species are commonly of the same genera as found in spruce-fir stands and some of the Douglas-fir stands.

Fauna - Larch stands are quite similar in understory species and in fauna to Douglas-fir and fir-spruce forests. However, larch is a deciduous conifer and does let more light into the stand during part of the year. This difference in light factor makes the stands preferable to wildlife on certain occasions.

Soils - In eastern Oregon larch is on Mollisols and particularly on the north and northeast slopes where there is an overburden of deep, absorptive Vitrandept ash. In the northern Rockies it is on Inceptisols, Alfisols, and Mollisols.

Land Use - Much of the land is heavily forested, yielding wildlife habitat, livestock forage, and recreation as well as timber. Mining is important in northern Idaho and western Montana. A very small percentage of the land is cropped. Forage and grain grown in some of the valleys provide feed for dairy cattle and other livestock.

No. 26 - LODGEPOLE PINE

Physiography - High mountains with less than 20 percent of the area gently sloping. Elevations range generally from 4,000 to 11,500 feet; local relief is over 3,000 feet. The forest is best developed on gentle slopes, but many stands are found on rough and rocky terrain.

Climate - Commonly lodgepole pine is on sites of 80 to 120 days frost-free season but seems to be tolerant of frost at most any time of year. Average annual rainfall in all the provinces where it is found can be as low as 20 inches although it can grow well under 50 inches of precipitation. Precipitation to evaporation ratio during frost-free season in lodgepole areas is commonly 20 percent and often 40 percent. The stands are adapted to a variety of rainfall distribution in that for south Cascade and mid-Sierras lodgepole stands receive 50 to 60 percent of their annual precipitation in the months of December to March. Yet, in the middle Rockies only 15 to 35 percent of precipitation occurs in the cold months.

Vegetation - Lodgepole forests are commercially defined as stands with 50 percent or more lodgepole pine. Ecologically, they are seral to some of the western interior coniferous forests. "Doghair" stands often develop after fires. Understory species, if present, are of about the same genera as found in stands of interior Douglas-fir, larch, and spruce-fir. Herbage production can be 0 to 50 pounds per acre in dense stands or 2,000 to 3,000 pounds per acre where clearcuts, burns, or stand conversions to a different coniferous stand are carried out. Of course, the productivity declines with time and in 10 to 20 years will return to a very low production status.

Fauna - Lodgepole stands have about the same fauna as Douglas-fir, larch, and spruce-fir forests of the same elevational zone. Low productivity of understory species in many cases would probably be quickly limiting to the number of animals supported. During any action programs to restrict the extent of lodgepole stands, it should be remembered that islands of uncut lodgepole provide excellent escape routes and protective refuge or cover for big game animals.

Soils - In the Sierras lodgepole occupies soils of the order Ultisols. In eastern Cascades of Oregon lodgepole occupies Entisols. In the Blue Mountains of eastern Oregon lodgepole grows best on Vitrandept ash which deeply overburdens bedrock or Mollisols. In the Rocky Mountains lodgepole occupies Inceptisols, Mollisols, and Alfisols.

Land Use - Much of the land is forested. About 80 percent is owned by the Federal Government. In addition to timber, the forest yields water, wildlife habitat, and recreation. Several National Parks occur within the area.

No. 27 - REDWOOD

Physiography - The redwood ecosystem is restricted to the low coastal mountains of northern California and the extreme southern portion of Oregon. Less than 20 percent of the area is gently sloping. Local relief ranges from 1,000 to 3,000 feet.

Climate - The climate is moist and temperate. Average annual precipitation is near 60 inches of which 10-25 percent falls in the warm season, 60-70 percent in the December-March period. Normal annual pan evaporation is 40-50 inches. The ratio of precipitation to evaporation for the frost-free season is 20-40 percent.

Vegetation - The vegetation is a dense forest of very tall evergreen, needleleaf trees, sometimes with much undergrowth. Twenty percent or more of the stand is redwood. The dominant plants are redwood and Douglas-fir. Other major components of the vegetation include grand fir, salal, Pacific waxmyrtle, coast rhododendron, western hemlock, and box blueberry.

Fauna - The Columbian black-tailed or coast deer is present in the redwood ecosystem. Elk use the ecosystem in some areas but are much less numerous than in the past. Mountain lions and bobcats and black bears may be seasonally active within the forest. The red-tailed hawk, screech owl, and great horned owl feed on mice and other small animals on the forest floor. The sharp-shinned hawk and Cooper's hawk prey chiefly on birds. The band-tailed pigeon may occur as a summer resident. The blue grouse is the most common ground-nesting bird. Other birds characteristic of the ecosystem include the pileated woodpecker, gray jay, brown creeper, hermit warbler, and red crossbill.

Soils - Soils belong to the order Ultisols. Base saturation is low; organic matter content is high. A relatively thin subsurface horizon of clay accumulation is present (Haplohumults).

Land Use - Most of the land is in privately owned farms, ranches, or forest. Lumbering is the major industry. Only about 10 percent is grassland used for grazing. The cultivated land in valleys, less than 5 percent of the total area, is used mainly for forage and grain for dairy cattle.

NO. 28 - WESTERN HARDWOODS

Physiography - In the California and Oregon hardwoods region topography ranges from tablelands of where 50-80 percent of the area is gently sloping and the relief is only 300-500 feet to low mountains where less than 20 percent of the area is gently sloping and the local relief is 1,000 to 3,000 feet. The Rocky Mountain portion (mostly aspen areas) varies considerably. In the Hawaiian Islands the forests occur on coastal plains or plateaus and on gentle to precipitous mountain slopes up to about 9,000 feet.

Climate - The west coast (continental) portion of this ecosystem has rainy winters but dry summers. Average annual precipitation ranges from 15 inches in California to 48 inches in Oregon, occurring mostly as rain between the months of November and May. Normal annual pan evaporation ranges from about 40 inches in Oregon to nearly 100 inches in southern California. The ratio of precipitation to evaporation during the frost-free season ranges from 0.2 to 0.6. The climate of the widely scattered Rocky Mountain portions corresponds to that described for adjacent or surrounding types. The forests in the Hawaiian portion are in the main on the wetter windward slopes of the islands. A more detailed description of the climate of Hawaii is listed under No. 43 - Hawaiian Grasslands.

Vegetation - The continental United States portions of the western hardwoods includes forests in which 50 percent or more of the stand is hardwood species, except where western white pine, sugar pine, or redwood comprises 20 percent or more in which case the ecosystem would be classified as white pine or redwood. The vegetation is a forest of low to medium tall broadleaf deciduous or evergreen trees, sometimes with an admixture of low to medium tall needleleaf evergreens, often with an understory of grass and shrubs. In the California and Oregon portions dominant species include Oregon white oak, Coulter pine, digger pine, coast live oak, canyon live oak, blue oak, valley oak, and interior live oak. In California this ecosystem lies mainly between the annual grasslands and the chaparral and mixed conifer zones. The widely scattered Rocky Mountain and plains states "hardwood" portion is primarily quaking aspen stands with an understory of grasses, forbs, and shrubs. In many areas where the aspen stands are inclusions within sagebrush or conifer types, they are very important sources of food and cover for various wildlife species. Cottonwood becomes dominant on plains, more or less replacing aspen.

Hawaiian types within the hardwood ecosystem are, in general, stratified by elevation. At lower levels occur the guava mixed forest, then the ohia-lehua forest, the koa forest, and above about 6,000 feet the koa-mamani parkland. Dominant species in the guava mixed forest are guava, java plum, koa-haole, hau, Christmas berry, lantana, alahee, akia, uluhe

fern, and grasses. Dominant species in the ohia-lehua forest are ohia-lehua, hapuu pulu, hapuu ii, ei-ei, olapa, kopiko, lama, pilo, kukui, kolea, loulu, pukiawe, uluhe fern, and the lobelias. Dominant species in the koa forest are koa, hapuus, pilo, amaumau, ohia-lehua, pukiawe, and ohelo. Dominant species of the koa-mamani parkland are koa, mamani, naio and pukiawe, ohelo and naenae. Mamani extends to much higher elevations than koa. Forage production for livestock is important use of land in these forest types. Thousands of acres of the forests have been opened up and replaced by understories of grasses and legumes. Grasses common to the medium and higher elevations are kikuyu, manieie, bermuda grass, orchard grass, pili, rye grasses, hair grass, pangola grasses and paspalum grasses. Production on the grass types often exceeds two tons per acre of air-dry herbage.

Fauna - In California several sub-species of the mule deer are numerous in various parts of this ecosystem. The now extinct California grizzly was once numerous. An occasional black bear may come down from forests at higher elevations. Mountain lions are no longer numerous; the largest numerous predatory animals are the coyote and the bobcat while avian predators include golden eagles, red-tailed and other hawks. Two endangered species, the California condor and the San Joaquin kit fox, may occur in the ecosystem. California quail may be abundant at lower elevations while mountain quail may winter at the higher elevations in this ecosystem. The striped skunk is widespread. Among the more common small mammals are the beechy ground squirrel, kangaroo rat, pocket gopher, and a number of types of mice. Other species occurring in the area are listed under the Annual Grasslands ecosystem. The fauna of the Oregon oakwoods is somewhat similar, but species representative of the southern part of the California oakwoods may not be present and more northern species such as the ruffed grouse are. Deer are common; elk were in the past. The western gray squirrel frequents the garry oak. The fauna of the aspen areas throughout the Rocky Mountain area is essentially that of the adjacent or surrounding ecosystems, but the aspen areas serve as important food and shelter areas for many species of wildlife. Where the hardwoods occur in river bottoms in the plains, they are a home for many arboreal and forest edge species that are not present in the surrounding open country. In Hawaii introduction of different plants, wildlife species, and of domestic stock insect and diseases that went wild, has had a tremendous effect on both the flora and fauna that originally occurred. Many species of plants and animals are rare or endangered.

Soils - In Oregon the soils are deep but have well developed illuvial horizons (Argixerolls). Drainage is generally good. Farther south in California the surface horizons are somewhat lighter and lower in organic matter, but the illuvial horizon of clay accumulation is again present (Xeralfs). Soils of the Hawaiian Islands consist mainly of Ultisols, Oxisols, and Inceptisols. The Ultisols (Humults) develop

where rainfall is high throughout the season and are used for cultivation and forests. Oxisols consist of Orthox where moist conditions prevail and Ustox on continuously dry sites. These sites are also used for cultivation and pasture. Inceptisols are common on the slopes and are mostly in woods and pasture. A large area of miscellaneous soil types (unclassified) makes up the central portion of the Island of Hawaii.

Productivity Classes

In California the productivity classes described under No. 42 - Annual Grasslands are in general applicable to the Western Hardwoods, which is adjacent and intermixed geographically. Similarly, in addition to the notation under the vegetation section, the writeup on No. 43 - Hawaiian Grasslands may be of value when considering the productivity of the Hawaiian portion of the Western Hardwoods. For the areas in the Rocky Mountains, the potential herbaceous productivity of the western aspen runs quite parallel with the timber productivity classes. The deeper, more productive soils produce a greater amount of forage as well as tree increment. However, the herbaceous understory is also influenced by the density of the aspen overstory. The level of the water table is also an important factor in herbage production. Some of the higher herbage producing sites have a water table within 1 to 2 feet of the soil surface.

Herbage production under heavy stands of aspen may be as low as 100 or 200 pounds per acre. Open stands may produce over a ton per acre. The herb understory under pristine condition has a proportion of about two-thirds forbs and one-third grass with various mixtures of shrubs.

NO. 29 - SAGEBRUSH

Physiography - The provinces where sagebrush is prominent are principally the Columbia plateau, central portion of Great Basin, Wyoming Basin, Colorado plateaus, and some of the lower reaches of adjacent mountains. This broad ecosystem occupies vast plains and plateaus derived from lava flows, ancient lake beds, and broad basins of alluvium. The more individual plateau sections are usually delineated in terrace and table-like fashion and range from rolling lava plains to maturely fringed and dissected mesas. Elevational range is broad, roughly 600 feet to 10,000 feet.

Climate - Normal length of frost-free season is 120 days but is reduced to only 80 days at certain mountain sites. Annual precipitation is 5 to 12 inches (some places almost 20 inches) with 40 to 50 percent of it coming in the December to March period and only 25 to 40 percent occurring in the warmer half of the year. Precipitation is only 20 percent of the evaporation potential during the frost-free season.

Vegetation - The sagebrush ecosystem is characterized by shrubs, principally of the genus Artemisia, which are usually 1 to 7 feet high. In some situations other shrubs are part of the vegetation composition. In other cases, grasses such as those of the genera Argopyron, Festuca, Poa, and Bromus as well as broadleaved herbs are found in the understory.

Fauna - Pronghorn antelope use parts of this shrub and shrubsteppe rangeland yearlong, whereas mule deer prefer to use sagebrush rangeland only during the winter. Utah prairie dog is an endangered species of this biome. Other wild mammals which are principal inhabitants are Great Basin coyote, blacktail jackrabbit, pygmy cottontail, Ord's kangaroo rat, and Great Basin kangaroo rat.

Bird populations are low during the breeding season, averaging only about 25 pairs per 100 acres. The major influent birds include the Cooper hawk, red-tailed hawk, Swainson hawk, golden eagle, bald eagle, marsh hawk, prairie falcon, burrowing owl, and long-eared owl. The sagegrouse and chukar are important game birds. Over fifty additional species of birds nest within the ecosystem.

Soils - In the Columbia plateau province sagebrush occupies soils of the Mollisols order with black friable organic surface horizons and high in bases. Inceptisols (Andepts) of ashy nature are conspicuous in parts of the Columbia plateau. In the Great Basin and part of the Wyoming Basin the sagebrush soils are of the order Aridisols which have pedogenic horizons, are low in organic matter, may or may not have a clay horizon, and may or may not have

accumulations of various salts. In part of the Colorado plateaus province, as well as part of the Wyoming Basin, the sagebrush soils are of the order Entisols, which have no pedogenic horizons. The remainder of the sagebrush sites in the Colorado plateaus province are soils of the orders Aridisols and Mollisols.

Land Use - Most of the land within the sagebrush ecosystem is used for sheep and cattle grazing. The type is used principally in the spring and fall. Where sufficient water is available, irrigation ranching and farming is practiced. Principal crops are hay, grain, potatoes, and beets.

Productivity Classes

Class 1 - Productivity class 1 (75-100%) represents the best growing conditions in the sagebrush ecosystem. It includes the most productive sites of the sagebrush steppe and the wheatgrass-needlegrass shrubsteppe (Kuchler classification). Characteristic physiognomy is dense to scattered shrubs and dense to open grasslands. Dominant species of the sagebrush steppe are big sagebrush, bluebunch wheatgrass, and Idaho fescue. Other important species are balsamroot, Sandberg's bluegrass, and lupine. Dominant species of the wheatgrass-needlegrass shrubsteppe are western wheatgrass, needle-and-thread, and plains bluegrass. Herbage production varies from 1,500-2,000 pounds per acre. Forage production is from 500 to 700 pounds per acre.

Class 2 - This productivity class of the sagebrush ecosystem includes the lower production portion of the sagebrush steppe and the wheatgrass-needlegrass shrubsteppe. The physiognomy and dominant species are the same as in productivity class 1. Herbage production is from 1,000 to 1,500 pounds per acre. Forage production is from 300 to 500 pounds per acre.

Class 3 - This class includes the more productive portion of the Great Basin sagebrush type (Kuchler's classification). Average annual rain is near 10 inches per year. Physiognomy is characterized by dense to open brush 1 to 3 feet in height with various mixtures of grass and forbs. The dominant shrub is big sagebrush. Some important associated species are shadscale, hopsage, ephedra, and milk vetch. Herbage production is from 500 to 1,000 pounds per acre. Forage production varies from 100 to 200 pounds per acre.

Class 4 - Productivity class 1 is the area of lowest moisture regime of the sagebrush ecosystem. Rainfall is less than 10 inches and evaporation is high. Physiognomy is similar to class 1, except that the brush is more scattered and often of lower stature. Dominant species in addition to big sagebrush are black sagebrush and low sagebrush. Herbage production is from 0-500 pounds per acre. Forage production is from 0-150 pounds per acre.

HERBAGE PRODUCTION - Sagebrush (29)

Class	Herbage Production (lbs./Acre)
1	1,500 - 2,000
2	1,000 - 1,500
3	500 - 1,000
4	0 - 500

No. 30 - DESERT SHRUB

Physiography - This composite of various desert shrublands contains the salt flats of Great Salt Lake, the southwestern desert plains and plateaus, the western third of the Great Basin's mixture of mountains and basins, eastern edge of the Great Basin, parts of Wyoming and Big Horn Basins, and parts of the dissected Colorado plateaus.

Climate - Normal length of frost-free season is 120 days in the more northerly parts of the shrub provinces, but it is 200 days in the Southwest. Annual precipitation is just 5 to 10 inches. In the western portion of the province where Pacific climate has an influence 50 percent or more of the meager precipitation occurs in the winter period, whereas in the more eastern portions which are under the influence of continental or Rocky Mountain weather only 15 to 25 percent of the precipitation occurs during the winter period. The low precipitation is only 20 percent of the evaporation potential during the frost-free season.

Vegetation - The vegetation is characterized by xeric shrubs varying in height from four inches to many feet. Stands are generally open with a large amount of bare soil and desert pavement exposed. However, some stands may be relatively dense. Understory vegetation is generally sparse. During years of above average rainfall, annuals may be conspicuous for a short period of the year. Classification of the desert shrub ecosystem into productivity class is based on the potential for herbage production. Production varies greatly from year to year depending on the moisture supply.

Fauna - There is a great diversity of habitat in the desert shrub ecosystem. Consequently, the fauna is quite varied in species. However, the dominants are characteristically species of rats and pocket mice. In the saltbush-greasewood community the pale kangaroo mouse and little pocket mouse are common while animals associated with black sage are the desert woodrat and Nuttall's cottontail. The black-tailed jack reaches its greatest number in the greasewood sites. The cactus mouse and desert kangaroo rat are abundant in the saltbush desert. Merriam's kangaroo rat is strongly associated with creosote bush. Other important species are the long-tailed pocket mouse and antelope ground squirrel. Larger mammals common to the desert shrub are the desert kit fox, coyote, and western spotted skunk. Desert mule deer and peccary are found with the Palo Verde cactus shrub. Many desert birds are very selective in their type of habitat. Greasewood may furnish a permanent residence for the longerhead shrike. Areas where tall cactus is plentiful furnish homes for many bird species like the

Gila woodpecker, several species of owl, the purple martin, and others. Gambel's quail, cactus wren, and the roadrunner are common in the southern part of the desert shrub ecosystem. Reptiles include numerous species of snakes and lizards including the Gila monster of the tall cactus community. The Sonoran pronghorn is classed as an endangered species; few if any animals are left in southern Arizona. The residual population is almost entirely Mexican.

Soils - The soils of this desert shrubland composite include soil orders Aridisols (with pedogenic horizons) of the Great Basin and southwestern desert plains and plateaus, the Entisols (with no horizons) plus the Aridisols of Wyoming Basin and Colorado plateaus, as well as the unclassified Great Salt Flats.

Land Use

In the northern extension of this ecosystem livestock grazing is the principal industry. Much of this grazing is done in the winter. Where irrigation water is available, ranching and farming are practiced. Principal crops are hay and small grains. In some areas potatoes and sugar beets are grown.

In the Sonoran basin and southern Arizona and New Mexico limited grazing is done at favorable times. Irrigation farming is practiced where water is available. Crops such as cotton, citrus fruits, winter vegetables, and alfalfa are grown.

Productivity Classes

Class 1 - This class includes one of the major types (Kuchler's classification) of the desert shrub ecosystem. The mesquite bosque has a relatively high potential. Better sites in this type, those that are flooded periodically, have produced near 1.00 ton of herbage per acre where the mesquite cover has been reduced artificially. This production may be indicative of its original potential. The dominant plant species is mesquite. Herbage production on the more frequently flooded sites of this type is between 750 and 1,000 pounds per acre. Forage production is from 0 to 500 pounds per acre. Characteristic physiognomy is a forest of low deciduous trees.

Class 2 - This class includes the higher moisture sites of the saltbush-greasewood type. Greasewood, saltgrass, and pickleweed are dominant and associated species. Herbage production varies from 500 to 750 pounds per acre. Forage production is 50 to 200 pounds per acre. Physiognomy is low to medium brush, succulent forbs, and with or without grass.

Class 3 - Productivity class 3 (25-50%) includes the more productive sites in three major types: saltbush-greasewood, blackbrush, and Palo Verde-cactus shrub. It also includes average sites of the mesquite bosque. Dominant species of the saltbush-greasewood type are shadscale and greasewood. Other important species are budsage, saltgrass, and winter fat. Dominant species of the blackbrush type is blackbrush. Dominant species of the Palo Verde-cactus shrub type are Palo Verde and prickly pear. The cholla cactus, some of the larger cacti such as saguaro, and bursage characterize the type. The type occurs on the rougher topography than the other types. Production varies from 100 to 250 pounds per acre. Forage is from 50 to 150 pounds per acre. The physiognomy is characterized by shrubs and low trees with varying amounts of succulents.

Class 4 - Productivity Class 4 (0-25%) is associated with the drier and hotter portions of the desert shrub ecosystem. Two types (Kuchler's classification), the creosote bush and creosote bush-bur sage, are included in this productivity class. Dominant plant species of the creosote bush type is creosote bush. In the creosote-bur sage type creosote bush and white bur sage are dominant. The types are characterized by open stands of low to medium shrub. Herbage production is from 40 to 100. Forage production of both types is from 0 to 40 pounds per acre.

HERBAGE PRODUCTION - Desert Shrub (30)

Class	Herbage Production (lbs./Acre)
1	750 - 1,000
2	500 - 750
3	250 - 500
4	0 - 250

No. 31 - SHINNERY

Physiography - This ecosystem covers considerable areas of sand hills and river dunes across (the major portion occurs along the Canadian River) the southern Great Plains. This ecosystem is estimated to occupy about six million acres. The valley of the Canadian River is estimated to be 1,000 feet below the surrounding areas cut deep into red sandstone and 5 to 20 miles wide. The landscape is of terraces, mesas, cliffs, and side canyons. Water, when low, disappears and reappears through sand beds.

Climate - The shinnery ecosystem is rather small geographically; thus, the climate for the area is relatively uniform. The frost-free season is 180-200 days. Precipitation ranges from about 15 inches in New Mexico to 25 in Oklahoma. Two-thirds to three-fourths of the precipitation falls in the warm season; winter precipitation is low. Evaporation is several times the precipitation. During the warm season precipitation is a quarter of the evaporation on the west, one-half on the east.

Vegetation - The shinnery ecosystem vegetation is a midgrass prairie with open to dense stands of broadleaf deciduous shrubs and occasional needleleaf low trees and shrubs. The major shrub species are shin oak, Havard's oak, redberry juniper, and mesquite. Little bluestem and side-oats grama are the most common grass species. Sand bluestem is sometimes locally common. Sandsage and small soapweed are the most common forbs (low shrubs).

Fauna - The fauna of the shinnery ecosystem is a mixture of species common in the surrounding grassland, pinyon-juniper, and shrub ecosystems with forest edge species also present along the river bottoms.

Soils - The bulk of the shinnery ecosystem is on Mollisol soils. The extreme western portion of Aridisol and two small areas are Alfisols. The "island" of shinnery far to the south is on Alfisols.

Productivity Classes

Class 1 - The most productive areas of this ecosystem produce an average of 2,000 pounds per acre. These areas have a high proportion of tall grass species such as big bluestem, sand bluestem, along with mid grasses such as side-oats grama and

little bluestem. The soils are mainly Mollisols (Calciustolls plus Haplustolls) which are medium to high in bases and moist during part of the growing season but also dry for extended periods. Most of the level areas are now dry farmed (cash-grain) or irrigated. Wind erosion is a problem requiring continuous cover crops. The trend for this area is to hay-crops.

Class 2 - The vegetation characterizing this productivity class is that adjacent to the land areas in drier condition. Average herbage yields are 1500 pounds per acre. The major species are little bluestem and side-oats grama with scattered stands of big bluestem and sand bluestem. The shrub species characteristic to this ecosystem occur as small dense patches. The soils are mainly Alfisols (Haplustalfs) but have less available moisture and approaching sand dune conditions. These areas are now used for native rangeland or farmed if conditions permit.

Class 3 - The vegetation characterizing this productivity class is a mixture of mid grass and short grasses as occurring on or near the outer edge of valleys before ascending the valley walls. This area receives run-in when it occurs, but the area is still dry for long periods. Herbage yield averages 1000 pounds per acre. The major species are three awns, gramas, and occasional areas of western wheatgrass. Shrub species such as shin and Havard's oak, sumacs, and redberry juniper occur more commonly here than elsewhere. Mesquite occurs as scattered low trees. The soils are mainly Aridisols (Haplargids, gently to moderately sloping). This area is in native rangeland.

Class 4 - This productivity class is represented by vegetation occurring on the more sandy areas (stabilized sand dunes). Herbage yields average 500 pounds per acre with sand and little bluestem the major species. Other species are big sandreed, giant and sand drop seed, and hairy and side-oats grama. Small soapweed and sandsage are the two most important forbs (low shrubs). The soils are mainly Entisols (Ustipsamments, moderately sloping) characterized by fine sand. These areas are still in native grasses and forbs.

HERBAGE PRODUCTION - SHINNERY (31)

Class	Herbage Production (lbs./Acre)
1	1,500 - 2,000
2	1,000 - 1,500
3	500 - 1,000
4	0 - 500

NO. 32 - TEXAS SAVANNA

Physiography - This ecosystem occupies the western end of the West Gulf Coastal Plain and the southern end of the Great Plains Province. It is more commonly referred to as the Rio Grande Plains of south Texas and the Edwards Plateau of south-central Texas. The Rio Grande Plains is alluvial in nature and possibly a deltaic plain of that river. It is a relatively flat plain about 400-600 feet above sea level that rises to 1,000 feet rather abruptly to the Edwards Plateau. The Edward Plateau itself reaches 3,600 feet at its western edge. The edges are maturely dissected by streams. The surface in its interior is a flatland traversed by dry valleys ("draws").

Climate - In this southernmost area of what is usually considered as range country the frost-free season ranges from about 250 to well over 300 days. Precipitation is from 20-30 inches, more than half of which falls in the warm season and less than a quarter in the December-March period. Annual evaporation is 70-80 inches; during the May-October period evaporation is about twice the precipitation.

Vegetation - This is a high-shrub savanna ecosystem with a dense to very open synusia of broadleaf deciduous and evergreen low trees and shrubs and needleleaf evergreen low trees and shrubs. The grass varies from short to medium and the herbaceous vegetation varies from dense to open. Mesquite is the most widespread woody plant. Others are Acacia spp., oaks, juniper, and ceniza along the Rio Grande valley and bluffs. Opuntia spp. are widespread. The herbaceous plants are mainly grass bluestems, three awn species, buffalograss, gramas, and curly mesquite and tobosa on the Edwards Plateau.

Fauna - The Texas savanna ecosystem is noted for the abundance of white-tailed deer and wild turkey. The collared peccary is common in some areas along the Rio Grande where several species of Mexican or tropical distribution make their only entry into the United States. Examples are the chachalaca and the coatimundi. Great numbers of white-winged doves once nested in brushy areas along the southern Rio Grande, but clearing of land for agricultural purposes has greatly reduced their numbers. The golden-cheeked warbler is a rare species. The mourning dove, scaled quail, and bobwhite are game birds in the ecosystem. A number of hawks and owls are present. The armadillo is an interesting mammal in the area. The fox squirrel is hunted in wooded areas along streams. Among the fur bearers are the ringtail and the raccoon.

Soils - Soils in the Texas savanna ecosystem are varied, but the different soil orders are unusually well correlated with the different plant type categories or areas within the ecosystem. The mesquite-live oak savanna, for example, is on the only Entisols within the ecosystem. The juniper-oak

savanna is almost entirely Mollisols, while an "island" of Alfisol within the above Mollisol corresponds with the boundaries of the mesquite-oak savanna. In the mesquite-acacis savanna Mollisols, Alfisols, and Vertisols occur.

Productivity Classes

Class 1 - The mesquite-live oak savanna vegetation type on the western Gulf Coastal Plains characterizes this productivity class. Herbage yields average 2,600 pounds per acre. Mean annual precipitation averages 29 inches but fluctuates greatly between years and droughts are common; consequently, herbage yield also greatly fluctuates. Major overstory species are live oak, shinook, and mesquite, and major grass species are seacoast bluestem, Texas wintergrass, curly mesquite, and three awn species. Most forbs are annuals and make up about 25 percent of the herbage production. Soils are Entisols (Ustipsamments) that are moderately sloping. These are Entisols that have textures of loamy sand and are intermittently dry for long periods. About four-fifths of vegetation type remains as rangeland of native shrubs and grasses. The remainder is irrigated or dry farmed.

Class 2 - This class contains a number of vegetation types. The mesquite-acacia savanna on the western Gulf Coastal Plain represents this productivity class. This is a dense to open grassland with broadleaf deciduous low trees and shrubs. Acacia spp. are the most common shrub with mesquite scattered throughout the type. The major grasses are seacoast bluestem, plains bristlegrass, and buffalograss. Herbage production averages 2,100 pounds per year with about 35 percent of that contributed by forbs. The most abundant forbs are oneseed croton, horsemint, and prairie coneflower. This class located on the Rio Grande Plains characterizes several soils due to the small escarpment elevations which rise westward. The soils are Mollisols (Haplustolls plus Argiustols, gently sloping), Alfisols (Haplustalfs plus Haplustolls and Calciustolls, shallow, gently sloping), and Vertisols (Pellusterts plus Chromusterts, gently sloping), and Mollisols (Calciustolls, shallow and gently sloping). All these soils have similar characteristic subsurface horizon high in bases, mostly shallow soils and intermittently dry for long periods during the warm season. Most of this vegetation type remains in ranges of native shrubs and grasses grazed by beef cattle. About 10 percent of the area, mainly along the Rio Grande and Nuces Rivers, is irrigated.

The mesquite-oak and juniper-oak savanna on the Edwards Plateau is another vegetation type in this productivity class. Herbage production averages 1,500 pounds per acre. Mesquite and oak dominate the open synusia of broadleaf deciduous trees of the mesquite-oak savanna while ashe juniper and live oak dominate the open synusia of trees of the juniper-oak savanna. The dominants of the herbaceous strata are similar

in both savannas and are little bluestem, curly mesquite, tobosa, and buffalograss. Prickly pear occurs spasmodically throughout the plateau. Forbs are of lesser importance. The soils are Mollisols (Haplustolls, shallow, 20 inches to bedrock, plus Pellusterts, gently to moderately sloping) in the mesquite-oak savanna and Alfisols (Haplustalfs plus Argiustolls, gently to moderately sloping) in the juniper-oak savanna. The juniper-oak savanna, in other words, occurs on the deeper soils that have a thin subsurface horizon of clay accumulation while the mesquite-oak savanna occurs on shallow soils that have subsurface horizons in which salts or carbonates have accumulated. More than four-fifths of the area is in rangeland or shrubs and grasses used by cattle, sheep, and goats. The remainder is used for dry farming. This is the Edwards Plateau which is very progressive in deer habitat management for economic returns to land, labor, capital, and management.

The ceniza shrub averages herbage production of 1,600 pounds per acre. The vegetation is open to dense stands of broadleaf deciduous and evergreen shrubs with a patchy synusia of grass. It is located along the lower Rio Grande valley and bluffs. The dominants are creosote bush, ceniza, and mesquite underlain with patches of gramas, curly mesquite, sacaton, Arizona cottontop, and three awns. Prickly pear is common. The soils are Vertisols (Pellusterts plus Camborthids and Torrents, gently sloping) which are clayey soils that have wide, deep cracks when dry that remain open intermittently for periods that total more than three months. Consequently, this can be very productive if adequate precipitation occurs. Most of the floor of the Rio Grande valley is now under irrigation. This would make up approximately 50 percent of the ceniza shrub type. The remainder occurs as valley slopes and bluffs which are still in native shrub and grass species. Conversion of brush to agricultural land has resulted in a drastic reduction in nesting habitat of the white-winged dove in the United States.

HERBAGE PRODUCTION - Texas Savanna (32)

Class	Herbage Production (lbs./Acre)
1	2,250 - 3,000
2	1,500 - 2,250
3	750 - 1,500
4	0 - 750

NO. 33 - SOUTHWESTERN SHRUBSTEPPE

Physiography - The southwestern shrubsteppe ecosystem occurs south of the Rocky Mountains. It occurs as relatively large blocks of almost level desert plains isolated between roughly parallel low mountain ranges of the Sonoran Desert, Mexican Highland, and Sacramento Section through southern Arizona, New Mexico, and Texas. This ecosystem occurs at a lower altitude than the pinyon-juniper ecosystem and is often referred to as the semidesert grass-shrub type.

Climate - Temperatures are not as variable as in ecosystems covering larger geographic areas; the frost-free season ranges from slightly less than 180 days in Arizona to more than 240 days at the southeastern boundary in Texas. Precipitation, half of which normally falls in the warm season, varies from 10 inches in the west to about 18 inches at the eastern boundary of the ecosystem. Evaporation is high; annual evaporation is 80-90 inches and during the warm season it is 4 to 10 times the precipitation.

Vegetation - The southwestern shrubsteppe ecosystem characterizes vegetation types ranging from short grass with scattered shrubs to shrubs with scattered areas with short grasses. This is due to relatively long transition from this ecosystem to the more woody pinyon-juniper and/or desert shrub ecosystems. Yucca is one of the most characteristic woody species; mesquite is abundant in many areas. Creosote and tarbush dominate the shrub layer. Black grama, threeawns, and tobosa dominate the herbaceous layer. Sideoats grama and curly mesquite are also important. The shrub-grass stands occupy shallow soils with none to little development. The grass-shrub stands occupy the soils with more development.

Fauna - Because of geographic proximity, the fauna of the southwestern shrubsteppe ecosystem is similar to that of the Desert Grasslands. Pronghorn and mule deer are the most widely distributed large game animals, but the common white-tail occurs in the eastern portion of the ecosystem in Texas. The collared peccary or javeline is common in the southern part of the ecosystem. The white-winged dove is locally important in Arizona, as is the more widespread mourning dove. The scaled and Gambel quail are present in most of the area, and the bobwhite reaches the eastern portion of the ecosystem. The blacktail jackrabbit, desert cottontail, kangaroo rat, wood rats, and numerous smaller rodents compete with domestic and wild herbivores for available forage and are preyed upon by the coyote, bobcat, golden eagle, great horned owl, red-tailed hawk, and ferruginous hawk.

Soils - In the western portion of this ecosystem soils are primarily Aridisols with some Mollisols. The eastern portions, the Trans-Pecos shrub savanna, are in the main Aridisols in the north and Entisols in the south. Kuchler's notation of occurrence of juniper falls entirely in the Entisol soil area.

Productivity Classes

Class 1 - The grama-tobosa shrubsteppe type that has a low shrub population of creosote bush and yucca characterizes this productivity class. Herbage production rates average 400 pounds per acre with ranges from 450 to 600 pounds. Black grama and tobosa occur most common. The soils are mainly gently sloping Aridisols that have a loamy horizon of clay accumulation and usually with a horizon of large amounts of calcium carbonate or gypsum. The Trans-Pecos shrub savanna where the junipers occur commonly also haracterizes this productivity class. This type occupies the Stockton Plateau which is the southwest portion of the Edwards Plateau. It is in a higher rainfall belt and at a higher altitude than the grama-tobosa shrubsteppe. The major grass species on this type are tobosa, curly mesquite, and buffalograss. Forbs are of lesser importance. Soils are mainly gently to moderately sloping Entisols which are clayey Entisols that have a regular decrease in organic matter content with depth, have a gravelly or stony surface in this area and usually less than two feet to the caliche layer. Four-fifths of this vegetation type remains as rangeland. The remainder is under irrigation or non-farm uses.

Class 2 - The Trans-Pecos shrub savanna with herbage yields averaging 300 pounds per acre characterizes this productivity class. Shrubs such as tarbush and creosote bush are common with a lower strata of short grasses such as tobosa, Chino grama, and bush muhley. Forbs are few. The shrubs and dwarf shrubs occur as stands that are dense or scattered; consequently, herbage production varies also. The soils are mainly gently sloping Aridisols (Caliorthids) that have a horizon in which large amounts of calcium carbonate or gypsum have accumulated and are shallow. This area is mainly rangeland at present.

Class 3 - The grama-tobosa shrub type with a relatively common occurrence of Joshua trees and also other species of yucca along with a grass synusia varying from open to dense represents this productivity class. Black grama and tobosa are the major species in the grass synusia. Herbage production varies considerably from 150 to 300 pounds,

giving an average of approximately 200 pounds per acre. This vegetative type occupies a small area in western Arizona. The soils are Aridisols (Durargids) that have a hardpan (duripan) that is cemented with silica and/or Entisols (Torriorthents) that are shallower than 20 inches to bedrock. These areas are now used as rangelands.

Class 4 - No one vegetation type of this ecosystem characterizes this productivity class. The class characterizes those areas tending toward the desert shrub ecosystem where shrub vegetation is more prevalent and herbage production averages 100 pounds per acre. Major shrub species are creosote bush, tarbush, Joshua tree, or juniper while major grass species are tobosa and mixed grama stands. Soils are mainly gently to moderately sloping with stony surface of the Aridisols (Durargids) that have a hardpan and Entisols (Torriorthents) that are shallower than 20 inches to bedrock. This area is still used as rangeland.

HERBAGE PRODUCTION - Southwestern Shrubsteppe (33)

Class	Herbage Production (lbs./Acre)
1	450 - 600
2	300 - 450
3	150 - 300
4	0 - 150

NO. 34 - CHAPARRAL-MOUNTAIN SHRUB

Physiography - The Chaparral-shrub occupies mountain areas over 3,000 feet elevation in northern California and occurs at sea level to low mountains (sea level to 3,000 feet) in the southern part of California Coast Range. In the Middle Rockies this shrub type is in mountains over 3,000 feet elevation. In the Gila Mountain province it occupies low mountains and in the southern Great Basin it occupies both low and high tablelands.

Climate - Length of the frost-free season in much of California shrub area is 160 to 200 days, depending on latitude and elevation. However, one area along the southern coast has a frost-free season of 300 days. In the Middle Rocky Mountains the period is 80 to 120 days, depending on elevation. Gila Mountains have a frost-free period of 160 to 180 days, and in the southern Great Basin and Range province it is 200 days. Annual precipitation varies from 10 to 28 inches, sometimes more. California shrub area only receives 10 to 25 percent of its precipitation in the warmest season; the north part of the Great Basin and the Middle Rocky portion gets 40 to 50 percent in the warm season, whereas the Gila Mountain province and southern part of the Great Basin and Range province receive 50 to 66 percent of annual precipitation in the warm season. Year-round mild temperatures in much of the California shrub type tend to offset some of the disadvantages of lack of coordination between precipitation pattern and summer season. Furthermore, coastal areas receive some moisture from fog in summer. The precipitation is normally only 20 percent of the evaporation potential for the Middle Rocky, Gila Mountain, and southern Great Basin provinces. In California the precipitation is 20 to 40 percent of the evaporation potential.

Vegetation - The vegetation of the ecosystem consists of dense to open brush or low trees. Deciduous, semideciduous, and evergreen species are represented in the types. Some of the brush types are so dense that understory vegetation is practically eliminated while other types support a highly productive understory. Productivity classes in the Chaparral-Mountain Shrub ecosystem are based primarily on the potential productivity of the site. Recent activities of white man have altered the types to a degree that reconstruction of their original state would be difficult.

Fauna - The fauna is quite diverse from north to south in the Chaparral-Mountain Shrub ecosystem; however, some species are quite general. Deer and mule deer throughout the ecosystem and white-tailed in the south are the most important large mammals. Other large mammals, such as coyote, mountain lion, bobcat, blacktailed jackrabbit, ringtail, striped skunk, and spotted skunk have widespread distribution

in the ecosystem. Important species, such as javelina and the band-tailed pigeon, are found only in the southern part of the ecosystem. The woodrat is one of the most characteristic species of the ecosystem. Other small mammals include the ground squirrels and mice. Birds are very numerous in the brush types of the ecosystem throughout the year. Over a hundred species were identified in the scrub oak type in Utah. Over 40 resident birds were noted in the oak-juniper type. Some examples of birds from the oak-juniper are golden-fronted woodpecker, turkey, and bobwhite. Reptile species are quite numerous in the south portion of the ecosystem. Two rare and endangered species are found in the ecosystem and both in the Chaparral type. The range of California condor is partially within the Chaparral type. The San Joaquin kit fox is the other endangered species. A third endangered species, the masked bobwhite, has been extirpated from the United States portion of the ecosystem.

Soils - In the northern part of California the Chaparral-shrub occupies soils of the order Ultisols which are low in bases and subsurface horizons of clay and weatherable minerals. The remainder of the California portion of the Chaparral in the Coast Range occupies Mollisols (on steep slopes which are high in bases but without accumulations of clay), the Alfisols (with clay accumulations and sometimes with carbonate cemented horizon), and the Entisols (with no horizons, low organic, and some often less than 20-inch depth). In the Middle and Southern Rocky Mountain provinces this shrub unit occupies soils of the order Mollisols with subsurface horizon of clay. In the southern edge of Great Basin province and the Upper Gila Mountains the Chaparral-shrub occupies mainly soils of the order Aridisols of low organic content and which have a loam clay horizon.

Land Use - In the California portions of mountain shrubland, large portions of the area have been converted to range grass for livestock grazing and for fire fuel breaks. Thus with native grasslands and more open sections of shrub, production of range livestock is the principal enterprise of the area. In addition, the vegetation serves as erosion and watershed protective cover for some very precarious soils and terrain, and this is a critical and vital need to the croplands, high value developments, and urban areas below. Grassed fuel breaks and the required grazing treatment of them are a striking manipulation that is destined to become more common. Such brush conversion has also provided increased habitat for deer.

In the interior and southwest portions of the mountain shrub, livestock grazing is the prominent use and lands suitable for cropping and irrigation are most often used for production of forage crops.

Productivity Classes

Class 1 - Productivity class 1 (75-100%) includes the northern two-thirds of Chaparral type in California and southern Oregon and the more productive part of the mountain mahogany-scrub oak type. Precipitation ranks in the highest rating category for the ecosystem. Where the site is not fully occupied by thick brush, high yields of herbaceous vegetation are common.

Dominant plant species of the Chaparral type are chamise, species of manzanita, and species of California lilac. Chamise may form a dense impenetrable cover in places.

Gambel oak is dominant in this productivity class of the ecosystem but may be associated with substantial amounts of its associated species.

Herbage production for the productivity class is 1,500-2,000 pounds. Forage production may be as high as 900 pounds per acre, or it may be less than 100 pounds, depending on the thickness and species of the brush.

Class 2 - This productivity class includes moderately productive sites of the mountain mahogany-scrub oak type, the oak-juniper woodlands, and the transition between the two. Gambel oak and other deciduous shrubs may still hold dominance in the northern extension of the type but lose prominence to the evergreen species to the south.

The dominant species of the oak-juniper woodland are alligator juniper, one-seeded juniper, emory oak, and Mexican blue oak. Some of the better grasslike blue and side-oats grama, as well as numerous brush species, are associated with this type.

Herbage production for the productivity class is 1,000 to 1,500 pounds per acre. Forage production, depending on the thickness of the brush and species composition, will vary from 100 to 700 pounds per acre.

Class 3 - Productivity class 3 (25-50%) includes the less productive areas of the Chaparral which includes the part in southern California. The mountain mahogany phase of the mountain mahogany-scrub oak type is also included.

Dominant plant species for the Chaparral are the same as for the high productivity class. The dominant species of the mountain mahogany phase is mountain mahogany.

Productivity of this class is from 500 to 1,000 pounds of herbage. Forage production varies from 50 to 300 pounds per acre.

Class 4 - The coastal sagebrush type is included in this productivity class. It is characterized by low-growing brush (1 to 2 feet, generally).

Dominant species are California buckwheat, white sage, and black sage.

Herbage production for the class is from 0-500 pounds per acre. Forage production is 0 to 100 pounds per acre.

HERBAGE PRODUCTION - Chaparral-Mountain Shrub (34)

Class	Herbage Production (lbs./Acre)
1	1,500 - 2,000
2	1,000 - 1,500
3	500 - 1,000
4	0 - 500

NO. 35 - PINYON-JUNIPER ECOSYSTEM

Physiography - Pinyon-juniper woodland occupies portions of the Great Basin province with its intermingled basins and mountains and many of the Colorado Plateaus where its growing sites are often adjacent to sagebrush sites. However, juniper usually occupies rockier and rougher terrain than sagebrush. Where sagebrush is common to the plains, terraces, and gentle portions of plateaus, the pinyon-juniper woodland tends to occupy the adjacent contiguous sites of eroded and rough dissections.

Climate - Normal length of frost-free season is 120 days. Annual precipitation is 10 inches with 40-50 percent occurring during the warmer season in the Great Basin, whereas 50-66 percent occurs during the warm season in the Colorado Plateaus. Precipitation is normally only 20 percent of the evaporation potential during the frost-free season.

Vegetation - The name "pygmy forest" characterizes the pinyon-juniper woodlands. The trees occur as dense to open woodland and savanna woodland. Trees may grow to a height of 30 feet but are generally less than 15 feet. The form of the tree is bushy, being almost as wide as it is tall.

Herbage production outside of tree needles and fruits is determined to a large extent by the amount of tree canopy. However, soil factors that have an effect on the moisture regime also have control on the herbage productivity. These soil factors are texture, development of the B horizon, depth of solum, stoniness, and nature of the substrate. Slope or aspect is also a factor.

Fauna - The major mammalian influents in the pinyon-juniper ecosystem are the mule deer, mountain lion, coyote, and bobcat. Elk are locally important. The less important influents include the woodrat, white-footed mouse, cliff chipmunk, jack rabbit, cottontail, rock squirrel, porcupine, and gray fox. The ringtailed cat and spotted skunk occur rarely. The most abundant resident birds in the pinyon-juniper ecosystem are the gray titmouse, woodhouse's jay, western red-tailed hawk, golden eagle, red-shafted flicker, pinon jay, lead-colored bush-tit, and rock wren. Summer residents include the western chipping sparrow, night hawk, black-throated gray warbler, northern cliff swallow, western lark sparrow, Rocky Mountain grosbeak, desert sparrow, and western mourning dove. The common winter residents are: Shufeldt's junco, pink-sided junco, gray-headed junco, red-backed junco, Rocky Mountain nuthatch, mountain bluebird, western robin, and long-crested jay. Turkey are locally abundant during the winter.

Some reptiles are horned lizard, sagebrush swift, collar lizard, and Great Basin rattlesnake.

HERBAGE PRODUCTION - Pinyon-Juniper (35)

Class	Herbage Production (lbs./Acre)
1	600 - 800
2	400 - 600
3	200 - 400
4	0 - 200

Class 4 - Productivity class 4 is found on sites where the woodland cover is heavy; trees may have a crown cover of 50 percent or more. The class may also be found on the drier soils.

Dominants are the same as the other three classes, but the understory is sparse and may consist almost entirely of scattered cryptantha and prickly pear.

Herbage production is from 0-200 pounds per acre. Forage production is from 0-75 pounds per acre.

Soils - In the Great Basin province pinyon-juniper woodland occupies soils of the order Aridisols which have pedogenic horizons, are moderate to low in organic matter, and may have carbonate accumulation. In Colorado Plateaus the woodland occupies, besides the Aridisols, the soils orders Entisols which have no pedogenic horizons and the Mollisols which have organic surface horizon and high base content.

Land Use - The pinyon-juniper ecosystem is used principally for grazing and a limited amount of timber products. Christmas trees, pine nuts, and fence posts are the main timber products.

Productivity Classes

Class 1 - Productivity class 1 (75-100%) is associated with open or savanna woodlands and on the deeper (12"+) better developed soils and northerly aspects where moisture regime is most favorable to plant growth.

Dominant species are one-seeded juniper, Utah juniper, pinyon pine, one-leaf pine, and western juniper. Important understory species are big sagebrush, western wheatgrass, bluebunch wheatgrass, blue grama, cliffrose, bitterbrush, and Indian ricegrass.

Herbage production varies from 600-800 pounds per acre. Forage production is from 200 to 300 pounds per acre.

Class 2 - Productivity class 2 (50-75%) occurs on sites of fairly open woodlands and on soil comparable to productivity class 1. The same dominants and understory species are the same as productivity class 1.

Herbage production varies from 400-600 pounds per year. Forage production is from 150-200 pounds per acre.

Class 3 - Productivity class 3 (25-50%) occurs on sites with a moderate woodland cover or soils with lower water-holding capacity than the two higher productivity classes.

The dominant species remain the same, but the shrubs may be sparse or suppressed. Associated grasses will be thinned out to some extent.

Herbage production is from 200-400 pounds per acre. Forage production is from 75-150 pounds per acre.

NO. 36 - MOUNTAIN GRASSLANDS

Physiography - The mountain grasslands are mainly open untimbered areas, yet often adjacent to or surrounded by ponderosa pine, Douglas fir, or lodgepole pine at moderate elevation sites. At high elevations these grasslands are truly subalpine and are part of mountain slopes or faces adjacent to spruce-fir forests and patches of alpine fir or whitebark pine. They may also occupy the most well drained soils of valley-like areas intermingled with mountains, or they may occupy foothills, tablelands, or low mountains. The higher mountain settings can be rich with streams and lakes. These beautiful pastoral openings and exposures commonly provide unobstructed vistas of the mountain or mountains which are unobtainable on mountain terrain completely cloaked in forest.

Climate - Normal length of frost-free season for most of the mountain grassland area is 120 days. However, in the mountain valleys of the northern Rocky Mountains it is less than 120 days and only 80 days or less in high elevation situations. Annual precipitation for many of these grasslands is 20 inches and in the high mountains it is 30 inches or more. Of these amounts, 66 to 75 percent comes during the warrm season in central Colorado and east of the Divide in Montana. In the northern Rocky Mountain grasslands west of the Divide 50 to 66 percent comes during the warm season, and in the Palouse hills of the Northwest only 25 to 40 percent comes during the warm season. Annual precipitation is 30 to 35 percent of the annual evaporation potential.

Vegetation - Although mountain grasslands range from foothills at northerly latitude to high mountain sites, they are characterized by bunchgrasses from the genera Festuca and Agropyron. Productivity classes are related to total precipitation, the abundance of precipitation during the growing season, and soil factors. Abundance of desirable forbs appears to increase productivity of some of the higher elevation sites.

Fauna - In the foothill portion of mountain grasslands, pronghorn antelope are resident with mule deer, a winter visitor. Where there is an interface with the sagebrush ecosystem, common animals are black-tailed jackrabbit, pygmy cottontail and various mice. At low to mid elevations various subspecies of ground squirrels are present as well as the badger. Mid- to high-elevation grasslands seasonally support Rocky Mountain elk and mule deer. Well distributed throughout is the pocket gopher. Predators which are well distributed at high elevations are the bobcat, black bear, and coyote. Two of the more common birds present are the robin and horned lark. Marsh hawks, sparrow hawks, and golden eagles are common raptors.

Soils - In central Colorado the mountain grasslands occupy soils of the orders Aridisols and Mollisols with developed horizons. In the Yellowstone River area of south central Montana the grassland soils are of the order Entisols with no horizon development. In the grasslands of the northern

Rocky Mountains soils are of the orders Alfisols and Mollisols. Mollisols are also the major soils order of the Columbia Plateau's foothills or Palouse hills. Much of the central and eastern portion of rolling hill land is locally termed part of Palouse Prairie and has a wind laid soil of great depth.

Land use - Much of the lower elevation parts or foothill grasslands were plowed for production of small grain soon after settlement. The most notable example of this is the Palouse Prairie hills of north central Oregon and extreme eastern portion of State of Washington and adjacent parts of Idaho. Unbroken portions of the foothill grasslands on steep slopes and in canyons are used as livestock spring-fall range and as big game winter range, a particularly critical range resource to big game management. At moderate elevations the mountain grasslands are sometimes the site of livestock ranches. At higher elevation the grasslands are important summer ranges for big game and livestock, prime watersheds and recreation areas, as well as the traditional settings of sheep and herder.

Productivity Classes

Class 1 - This class is commonly associated with high elevation lands of or near subalpine character and whose distribution of precipitation is 66-75 percent occurrence in the growing season. It may possess five species of wheatgrass plus Idaho fescue and many other grass species. Forbs may make up 35 percent or more of the cover. Herbage production may vary from about 2,250 pounds to 3,000 pounds per acre.

Class 2 - This class may be of moderate to high elevation, yet reaching subalpine conditions. Desirable forbs may be 10-35 percent of the composition with prominent grasses being one of several fescues. Associated grasses may be of the genera Muhlenbergia, Stipa, Danthonia, and/or Agropyron. Moisture relations are apparently favorable by virtue of high elevation or at moderate elevations because of synchronization with the growing season. Herbage production may vary from 1,500 - 2,250 pounds per acre.

Class 3 - This class occupies low mountains and higher foothills in areas where not more than 40 percent of the precipitation comes in growing season. Its dominant grasses are Idaho fescue and bluebunch wheatgrass. The large forbs of genera Balsamorhiza and Helianthella are conspicuous. Herbage production may vary from 750 - 1,500 pounds per acre.

Class 4 - This class occupies foothills at northerly latitudes and at its lower edge is bordered and invaded by big sagebrush. Bluebunch

wheatgrass is the dominant and has about 300-500 bunches per 100 square meters. The interspaces are sparsely to fairly well covered with sandburg bluegrass and small forbs, mostly annuals. Herbage production may vary from 0-750 pounds per acre.

HERBAGE PRODUCTION - **Mountain Grasslands (36)**

Class	Herbage Production (lbs./Acre)
1	2,250 - 3,000
2	1,500 - 2,250
3	750 - 1,500
4	0 - 750

NO. 37 - MOUNTAIN MEADOWS

Physiography - Mountain meadows are defined here as wet to intermittently wet sites occurring in the forest zone of mountains in western U.S.A. Typically they are found on almost flat to gently sloping topography, such as valleys and basin-like areas along lakes and streams, which accumulate surface or subsurface water in the rooting zone for at least part of the year.

Climate - The major influence of soil moisture in this ecosystem (saturated soil at least part of growing season) is strongly related to local topography or geology rather than the climate of the zone. However, there must be adequate annual precipitation on the site or else run-off from higher areas to create soil moisture conditions required for meadows. The temperature regime of meadows will generally be that of the surrounding zone; yet, in some cases, meadows are the site of frost pockets in which temperature phenomenon deters establishment of some forest stands as effectively as intermittent high moisture in the rooting zone.

Vegetation - Grasses, sedges, rushes, and in some cases phreatophytic shrubs dominate the meadow. In best condition 70 percent of the ground is covered by vegetation; more than three-fourths of this may be perennial grasses. Sedges may constitute as much as 15 percent of the cover. Perennial forbs constitute only about 10 percent of the cover. Proportions of the various growth forms are easily manipulated by grazing pressure.

Fauna - Meadows often contain lakes and streams that provide water for wildlife. They are usually more productive of herbage than surrounding areas; thus, they daily attract fauna from the larger ecosystems in which they occur. The wetter meadows, especially those with streams or permanent lakes, are a home for such water-oriented species as beaver, waterfowl, and fish. The fauna of intermittently wet meadows may shift as moisture conditions change. For example, the burrowing rodents (and the predators which feed upon them) use meadows only during the drier periods. Deer, elk, and moose are among the large mammals that depend heavily upon meadows for food in certain ecosystems. In some ecosystems, the meadows are about the only source of suitable habitat for the nesting of migratory waterfowl.

Soils - Soils of mountain meadows are commonly recipients of alluviation, illuviation, or glaciation products from above. Furthermore, some of these processes are current events. Consequently, no classification by soil orders is attempted for this ecosystem.

Land Use - Small high elevation meadows commonly have not been cultivated. Only at lower elevations or in more accessible areas have meadows been

converted to hayland or drained and farmed. On the other hand, many small mountain meadows have been obliterated by road building and trails created by recreation horses. Disturbances to plant cover have, in some cases, resulted in cutting of stream beds to such depths that the water table has been lowered. As a consequence, such meadows lose their productive herbaceous cover and are invaded by brush or lodgepole pine stands.

Because of the potentially high productivity of meadow lands, those of considerable size warrant emphasis on range management and investment in physical improvements and intensive management. Those meadows of smaller size or of a very narrow or "stringer" nature should be managed primarily for wildlife and recreation management.

Productivity Classes - Length of wet period and depth of soil largely regulate productivity. Sedge and hairgrass meadows are the most productive, with yields of 3,000 pounds or more herbage per acre. Another type of meadow is one dominated by such shrubs as willow. These would be moderate to poor producers of grass type forage but a good source of browse for deer, moose, etc. The least productive meadows are those on shallow soils, or effectively shallow because of a tight soil horizon near the surface which restricts drainage and whose wet season is short. Such shallow and temporarily wet sites commonly produce only some unpalatable species of rush.

HERBAGE PRODUCTION - **Mountain Meadows (37)**

Class	Herbage Production (lbs./Acre)
1	3,000 - 4,000
2	2,000 - 3,000
3	1,000 - 2,000
4	0 - 1,000

No. 38 - PLAINS GRASSLANDS

Physiography - The plains ecosystem, also know as the "Great Plains," occurs on a broad belt of highland which slopes gradually eastward from an altitude of 5,500 feet near the eastern foothills of the Rocky Mountains to an altitude of 1,500 feet in Central United States, where it gives way to the prairie ecosystem. The most striking feature is the phenomenal flatness of the interstream areas depicting a great expansive fluviatile plain or alluvial slope. The eastern margin has been most exposed to erosion, being near the trunk line of drainage and in a climate of greater rainfall than the western edge. This grassland of 280 million acres is larger than any other vegetation region in the United States.

Climate - Temperatures vary considerably, with less than 100 days frost-free in the north to more than 200 days in Texas. This region is characterized by periodic drought. Average annual precipitation ranges from 10 inches in the north to more than 25 inches in the south, with 60-80 percent coming in the warm season. Normal annual pan evaporation is roughly four times the precipitation. Precipitation-evaporation ratio for the frost-free season is .30 to .50.

Vegetation - The grass life form of low stature and warm season predominates with a minor interspersion of forbs and shrubs. Vast stretches of this ecosystem are dominated almost exclusively by blue grama, with buffalo grass as a companion in many areas. However, the eastern half of the north half of this ecosystem is dominated by western wheatgrass and needlegrass. The occasional shrubs include juniper, silver sagebrush, silver buffaloberry, and skunkbush sumac in the northern reaches and rabbitbrush and mesquite in the southern part. Forbs are generally quite common, but many are ephemerals.

Fauna - The pronghorn is probably the most abundant large mammal. Bison were formerly important; but now mule deer and white-tailed deer are often abundant where cover is available. The white-tailed jackrabbit occupies the northern part of the ecosystem; the black-tailed jackrabbit the area south of Nebraska. The desert cottontail is widespread. The lagomorphs, the prairie dogs, and a variety of small rodents are preyed upon by the coyote and a number of other mammalian and avian predators, one of which, the black-footed ferret, is classed as an endangered species. The lesser prairie chicken, formerly abundant, is now classed a rare species. Sage grouse, greater prairie chickens and sharp-tailed grouse are present in the area. Among the

many smaller birds are the horned lark, lark bunting, and western meadowlark. Stock pond construction has created an important "duck factory" in the northern Great Plains.

Soils - Soils are varied. Mollisols occur from the Canadian border to the southern boundary of the ecosystem in Texas, as do the Entisols. Alfisols and Aridisols are less extensive and are mostly in the southern portion.

Productivity Classes

Class 1 - The wheatgrass-bluestem-needlegrass type is located adjacent to the northcentral part of the prairie ecosystem and receives more rainfall (about 18 inches) than other areas of the plains ecosystem. Western wheatgrass, big bluestem, and needlegrass are the characteristic with mid- to tall-grass dominant. Woody plants are absent or grow sparingly along streams. Herbage production is 2,000 pounds per acre with 70 percent of that as forage. Fifty percent utilization is considered appropriate for maximum sustained yield. Soils are Mollisols which express the characteristic carbonate horizon but have a weak thin horizon of clay accumulation characteristic of Argiustolls and are gently sloping. Approximately one-fourth of this area is now in native grasses. The other three-fourths is used for croplands of cash-grains.

Class 2 - The wheatgrass-needlegrass type of the western Dakotas occurs as a moderately dense, short or tall, wide expanse of gently to moderately rolling grassland dissected by small deeply eroded intermittently flowing streams. The dominants are western wheatgrass, blue grama, needle-and-thread, and green needlegrass. Forbs and woody plants occur sparingly. Herbage production is 1,500 pounds per acre with 70 percent of that as forage. Fifty percent utilization is considered appropriate for maximum sustained yield. Soils are Mollisols with suborders of Argiborolls, plus Hapustolls that are gently sloping. Most soils have a subsurface horizon high in bases and a subsurface horizon in which clay has accumulated. Precipitation averages 15 inches per year. Three-fifths to three-fourths of the area is now in native grasses grazed by cattle and sheep. Irrigation is common along streams.

Class 3 - The grama-needlegrass-wheatgrass and wheatgrass-grama-buffalo grass types in the 12-inch precipitation belt represent this productivity class. This is a rather short fairly dense grassland dominated almost exclusively in many places by blue grama. Other associated dominants are western wheatgrass,

needle-and-thread, and buffalo grass. Juniper occurs occasionally in places. Herbage production averages 1,000 pounds per acre with 60 percent of that as forage, due to herbage production's being 50 percent short grass plants. Fifty percent utilization is still considered appropriate for maximum sustained yield. Soils are mainly gently to moderately sloping Mollisols and Entisols which are intermittently dry for long periods during the warm season and usually have a horizon of clay and calcium carbonate accumulation. A smaller area of Aridisols occurs in this type. About three-fourths of the area is now in grassland and about 5 percent is dryfarmed. The remainder is either irrigated or classified as open woodland of western red cedar.

Class 4 - This production class characterizes the grama-buffalo grass and the mesquite-buffalo grass of the southcentral Great Plains. Annual precipitation (20 inches) exceeds northern areas of this ecosystem; however, high annual average temperature reduces the effectiveness of it. Blue grama and buffalo grass are exclusively the dominant herbaceous plants. They form a fairly dense grassland. Mesquite commonly occurs in the southeastern portion of this ecosystem. Herbage production averages 500 pounds per acre, with 60 percent forage. Sixty percent utilization is possible due to the native short grasses outstanding resistance to grazing, partly because of their low stature. The soils are mainly Mollisols and Alfisols, with a scattering of Entisols. Topography ranges from gently sloping to moderately sloping. The most common characteristics of these soils are that they are intermittently dry for long periods, have a subsurface in which salts or carbonates and clays have accumulated, except the Entisols. About three-fifths of the area is now in grassland and one-fourth dryfarmed. The remainder is under irrigation.

HERBAGE PRODUCTION - Plains Grasslands (38)

Class	Herbage Production (lbs./Acre)
1	1,500 - 2,000
2	1,000 - 1,500
3	500 - 1,000
4	0 - 500

No. 39 - PRAIRIE ECOSYSTEM

Physiography - The prairie ecosystem is a relatively large contiguous grassland which lies between the deciduous forests of the East and shortgrass plains of the West on the flat to rolling hill land of Central lowlands. Topographic relief delineates the boundaries of this ecosystem with the 1,500-foot contour the western boundary and the 500-foot contour the eastern boundary. The northern limits extend into Canada while southern limits extend into south Texas. Most of the lands of this ecosystem, excluding those south of the Missouri River, are characterized as those of young glacial drifts and dissected till plains. The lands south of the Missouri River are older with well-developed drainage systems but still flat to rolling hill land.

Climate - The climate varies widely in an area stretching from the Canadian border almost to the Mexican border. Temperatures vary from a frost-free season of less than 120 days in the North to almost 300 days in the South. On the East from Texas to Indiana, the prairie boundary lies close to the 40-inch isohyet, decreasing to the North. On the West, the southern boundary is about 30-inch isohyet; while further north, the prairie reaches the 20-inch isohyet. In general, more precipitation occurs in the warmer part of the year. Ratio of precipitation to evaporation during the growing season varies from .6 to 1.0 from west to east.

Vegetation - The prairie ecosystem is known to many as the tall grass or true prairie with the bluestems constituting about 70 percent of the vegetation and reaching heights of 5 to 6 feet. Large numbers of flowering forbs also exist but are usually overshadowed by the grasses. Most of the plants are classified as warm-season plants. Woody vegetation is rare with willow occasionally occurring on the exceptionally moist areas of the northern part of the ecosystem and needleleaf evergreens and broadleaf deciduous trees scattered in the southern part.

Fauna - The American bison was the most numerous large mammal in the prairie ecosystem, and the pronghorn antelope is still present along the western portion of the prairie. Jackrabbits are common residents of the prairie; and cottontails are present when streams and cover occur. Burrowing rodents include ground squirrels, prairie dogs, pocket gophers, and many smaller rodents. Burrowing predators include the badger and the black-footed ferret, now considered an endangered species. The wolf once existed on the prairie in great numbers; one species, the Texas red wolf, is classed as an endangered species on the southern border of the prairie ecosystem. The coyote is still common. The northern portion of the prairie

ecosystem is an important breeding area for a number of species of migrating waterfowl. Many of these migrators winter on the coastal plains of Texas and Louisiana. Mourning doves have also become abundant as shelterbelt plantings have developed. Among the gallinaceous birds, the sharp-tail grouse, greater prairie chicken, and bobwhite are present in fair numbers. However, the northern greater prairie chicken is considered a rare species; and the Attwater's prairie chicken in south Texas is listed as an endangered species. Space prohibits mention of most of the species of a rich prairie fauna.

Soil - Soils in the prairie ecosystem are primarily Mollisols, with smaller areas of Entisols and one small area of Vertisols. Most have dark upper horizons.

Productivity Classes

Class 1 - This production class characterizes lands that are level with deep fertile soils and which receive adequate moisture for maximum production. Big bluestem, little bluestem, Switchgrass, Indian grass, and side-oats grama are the dominants. Herbage production ranges from 4,500 to 6,000 pounds per acre on the bluestem prairie. Seventy percent of the herbage is forage, with 50 percent utilization most satisfactory for maximum sustained yield. Soils are Mollisols, with dark organic-rich surface horizons. About 10 to 15 percent of this area is in permanent pasture of tame and native grasses. The remainder is cropland for corn and other feed grain crops.

Class 2 - This production class characterizes lands that have gently sloping clayey soils and receive adequate moisture for herbaceous plants, but summer droughts are common. Little bluestem and Texas needlegrass are dominants on the blackland prairie ecosystem in Texas; and Seacoast bluestem and coastal sacahuista are dominant on the bluestem-sacahuista prairie of the coastal plains of Texas and Louisiana. Herbage productions average 3,000 pounds per acre, of which 70 percent is forage. Fifty percent utilization is considered satisfactory. The soils are Vertisols that have a black or dark-gray surface horizon. About two-thirds of the area is now in cropland and one-sixth is in pasture; the remainder is in abandoned fields or narrow strips of woodland along streams.

Class 3 - The cedar glade and Nebraska sandhills grasslands represent this productivity class of the prairie ecosystem and are medium tall grasslands with an element of dwarf to medium shrubs

(broadleaf and cedar shrubs). These grasslands occur in gently to moderately sloping lands. Dominant species on the cedar glades are little bluestem, big bluestem, Indian grass, and baldgrass; while big bluestem, sand bluestem, and prairie sandreed are dominants on the Nebraska sandhill prairie. Herbage production averages 2,500 pounds per acre, with 70 percent considered forage and 50 percent usable to maintain maximum sustained yield. The cedar glades lie in a 42-inch precipitation belt, but soils are shallow and droughty; while the soils in Nebraska sandhills show weak pedogenic development and consequently become dry quickly during drought periods. The cedar glade soils fall into the Ultisols that have a thick horizon of clay accumulation, and the soils of the Nebraska sandhills are in the Entisols that contain easily weatherable materials. The similarity of these two is the extended period of droughtiness during certain times of the year. Most of these areas are in native grass ranges used by livestock.

Class 4 - This productivity class characterizes grasslands of the prairie ecosystem having a strong element of dwarf shrubs to scattered open groves of broadleaf deciduous trees, but not of such density to be called savanna. The sandsage-bluestem prairie and Fayette prairie represent this class with herbage yields of 1,500 pounds per acre. Forage yields are 60 percent of herbage yields with 40 percent utilization satisfactory. The dominant species on the sandsage-bluestem prairie are little bluestem, sand bluestem, sandsage, and hairy grama; while the dominants on the Fayette prairie are little bluestem and buffalo grass. The soils of the sandsage-bluestem prairie are Alfisols and Mollisols that have a subsurface horizon of clay accumulation that is relatively thin and brownish. The soils of the Fayette prairie are Vertisols which are clayey with a brownish surface horizon. About one-fifth of the area remains in native range grazed by beef cattle. The remainder is cropland for cash-grains.

HERBAGE PRODUCTION - Prairie Ecosystem (39)

Class	Herbage Production (lbs./Acre)
1	4,500 - 6,000
2	3,000 - 4,500
3	1,500 - 3,000
4	0 - 1,500

NO. 40 - DESERT GRASSLANDS

Physiography - The desert grassland ecosystem occurs as scattered blocks of grasslands occupying the tablelands having moderate to considerable relief of the Colorado Plateaus in Arizona, New Mexico, and Utah and also the plains with low mountains of the Mexican Highlands in southwestern Texas. Altitudes range 5,000 to 7,000 feet. These tablelands (or plateaus) vary from moderately to severely dissected into plateaus and canyons and describe as a ruggedness probably surpassed by few other parts of the world.

Climate - As the name implies, precipitation in this ecosystem is low, from 8 to 12 inches annually. Usually more than half falls in the warmer part of the year. During the frost-free season, evaporation potential is five times or more the normal rainfall. The frost-free season ranges from over 200 days in Texas to about 120 in Utah.

Vegetation - A grass life form predominates on these plateaus between dominant shrub life forms above and below this ecosystem. Transition zones show shrubs give way to galleta to black grama to blue grama. However, consociations of these species occur, but almost pure stands are the rule. Tobosa replaces galleta in the southern extensions in Texas of this ecosystem and three awn becomes the dominant in the northern extensions in Utah. This ecosystem is also a more open grassland with low shrubs in the northern extensions.

Fauna - Antelope are the primary larger mammals in the desert grasslands. Mule deer also occur. The coyote and bobcat are among the chief predators on black-tailed jackrabbits, cottontails, wood rats, and a large number of small rodent species, such as the kangaroo rat and deer mouse. Scaled quail range into the grasslands, especially where brush has invaded. Among the smaller birds of the grasslands are horned lark, several sparrows, loggerhead shrike, and nighthawks. Avian predators include the golden eagle, great horned owl, and various hawks.

Soils - Soils are made up almost entirely of Entisols with no pedogenic horizons and Aridisols also without pedogenic horizons and never moist as long as 3 consecutive months.

Productivity Classes

Class 1 - The grama-tobosa prairie-type vegetation characterizes this productivity class of the desert grassland ecosystem. It is an open grassland of rather low growth (herbage production is 750-1,000 pounds per acre) with scattered succulents. Woody plants are absent or

occur sparingly. Blue grama and tobosa are the characteristic dominants. Soils are mainly Entisols (Torriorthents) that are shallow (20 inches to bedrock), loamy, or clayey, never moist as long as 3 consecutive months, and on moderately to steep sloping lands. This class also characterizes some Aridisols (Calciorthids plus Torriorthents) that are gently sloping.

The grama-tobosa prairie vegetation is still used as rangeland for domestic livestock.

Class 2 - The grama-galleta steppe of northern Arizona and New Mexico characterizes this productivity class. Its herbage production averages 500-750 pounds per acre per year. Blue grama and galleta dominate this low to medium tall grassland. Woody plants such as mormon tea and succulent such as Opuntia and Yucca sp. occur more common than in the grama-tobosa prairie. This vegetation type is highly responsive to rainfall, causing production to vary considerably. The soils are mainly Aridisols (Haplargids and other Aridisols plus Torriorthents) that are gently to moderately sloping and never moist as long as 3 consecutive months. This class also occupies some areas of Entisols (Torriorthents).

Less than one-third of this land is privately owned and with the remainder held by Indians or the Federal Government. Most of the area is native rangeland. About 2 percent of the area is used for irrigation or dryland farming.

Class 3 - The open grassland with low shrubs known as the galleta-three awn shrubsteppe of southeastern Utah characterizes this productivity class of this ecosystem. Herbage production averages 250-500 pounds per acre per year. Three awn, galleta, sandsage, and mormon tea are the major species. Numerous other species of grass, forbs, and woody plants occur but less commonly. Soils mainly are Aridisols (Calciorthids plus Torriorthents) which gently or moderately slope and have a horizon in which large amounts of calcium carbonate or gypsum have accumulated. This class also occurs on some of the Entisols in the Utah area.

This area is used as rangeland for cattle and sheep grazing.

Class 4 - Some areas of the desert grassland ecosystem occur on relatively shallow sandy soils causing draughtiness. This situation occurs in the grama-tobosa prairie (the most producing vegetation type in this ecosystem), as well as on the galleta-three awn shrubsteppe (the lowest producing vegetation type in this ecosystem). The dominant species remain the same or close thereof, but herbage production drops to 0-250 pounds per acre, and the vegetation is usually very sensitive to hard use. The class characterizes the gently to moderately sloping Entisol soil areas in the desert grasslands ecosystem which are soils that have no pedogenic horizon but are still loamy or clayey and have a regular decrease in organic matter content with depth.

These areas are used as grazing lands for sheep and cattle.

HERBAGE PRODUCTION - Desert Grasslands (40)

Class	Herbage Production (lbs./Acre)
1	750 - 1,000
2	500 - 750
3	250 - 500
4	0 - 250

No. 41 - WET GRASSLANDS

Physiography - This ecosystem characterizes the narrow belt (1-50 miles) of the coastal wet prairies and marshes from the Mexico line to Long Island, New York, exclusive of the Florida, Georgia, and Carolinas coastline. It also characterizes the everglades and palmetto prairie of southern Florida and the tule marshes of the low fluviatile plain in the California trough (formed by San Joaquin and Sacramento Rivers and to the Pacific Ocean) and flood plains of the Greal Salt Lakes and other lakes in the Intermountain area.

The coastal prairie is a clay, alternating with sands, plain almost untouched by erosion except for the steep-sided channels of transverse streams whose bottoms may be 30 to 40 feet below sea level. The everglades are a permanent swamp with the palmetto prairie adjacent and to the north slightly drier. However, both occupy an extensive, almost flat, marl and limestone shelf generally covered with a few feet of muck and a little sand. The tule marshes of central California occur due to the Sacramento and San Joaquin Rivers forming natural levees which entrap water along these rivers and their low altitude (10 to 60 feet above sea level). Many lakes occur (many drained and used for cropland now) along these streams and are of the playa type; i.e., their water (when present) covers the broad flat silt floors of basins of internal drainage.

Climate - The Wet Grasslands ecosystem varies so greatly geographically that any general climatic description is of questionable value. Rainfall in the Central Valley of California may be less than 10 inches; thus, the wet conditions in the "tule marshes" are due primarily to topography and runoff. Other areas in the wet grasslands receive much more precipitation, up to over 60 inches, in the Florida Everglades. Similarly, length of the frost-free season ranges from practically all year in extreme southern Texas and Florida to less than 200 days in the northern end of the ecosystem on the upper Atlantic coast. Evaporation is many times the rainfall in California to less than the annual rainfall in the eastern portion of this ecosystem. In the farflung coastal portions of the ecosystem intrusion of salt water may have more effect on the vegetation than does climate or soil.

Vegetation - The coastal prairies (marshes) are occupied by cordgrasses, smooth cordgrass and saltmeadow cordgrass (with the latter more prevalent on the Atlantic Coast), saltgrass, and a few forbs. The vegetation forms a medium tall to very tall grassland, usually dense. The palmetto prairie and everglades are dense, medium tall to tall grasslands with scattered palms and shrubs in

the palmetto prairie and with scattered low to medium tall broadleaf evergreen trees and shrubs in the everglades. The major species in the palmetto prairie are wiregrass and saw palmetto. The major species of the everglade grassland are sawgrass and three-awns. The vegetation of the tule marshes is a tall graminoid vegetation consisting of various species of tules and bulrushes, cattail, and soft flag. Several species of sedges occur less commonly.

Fauna - The fauna of the Wet Grasslands varies as much as its geographical location. The ecosystem, especially its more marshy and open water areas, serves as a seasonal home for tremendous numbers of migratory waterfowl. The central valley of California and the coastal marshes of Texas and Louisiana are prime examples. Endangered species, such as the whooping crane and the Texas red wolf use the Texas coastal area, and the American alligator is a yearlong resident in the Gulf Coast and Everglades. Other endangered species that formerly made more use of the ecosystem are the Florida panther of the Southeast and the tule elk that once ranged out into the California tule marshes. Most of the fauna are tolerant of a moist or wet environment; many species from adjacent prairies and forests make extensive use of the wet grasslands. Fresh and brackish water fishes, reptiles, and amphibians are abundant and varied. The Everglades provides a good example of influent species from adjacent palmetto prairie, cypress swamp, magnolia forest, and mangrove areas. A slight change in water level causes marked changes in the habitat and the fauna. A very sketchy list of species includes white-tailed deer, Florida panther, black bear, raccoon, bobcat, opossum, skunks, bats, marsh and swamp rabbits, cotton rat, fox squirrel, and many others among the mammals. Avian fauna is very varied; many influent species are cited in descriptions of adjacent areas. Before the water level over much of the Everglades was lowered by drainage, the area was the home for large numbers of herons, egrets, limpkins, mottled ducks, Everglade kites, etc. Now the Florida great white heron is classified as rare; the Florida Everglades kite as endangered.

Soils - Soils in this system are extremely variable with all orders found in the continental United States being represented. The Entisol order is prevalent in the central valley of California.

Productivity Classes

Class 1 - The southern cordgrass prairie is the most productive vegetation type in the wet grasslands. The average herbage yield is 10,000 pounds per acre. Smooth cordgrass is the major species and considered highly palatable to cattle. Other common species are Carex spp., saltgrass, and tules. Forbs and shrubs are few to none. The construction of "walkway" levees has greatly improved the accessibility of this rangeland to livestock.

Soils are mainly Histosols (plant residues moderately decomposed, gently sloping) and Mollisols (Haplaquolls plus Udipsamments and Humaquepts) which are wet Mollisols that have a thick nearly black surface horizon and gray subsurface horizons.

About 50 percent of the southern cordgrass prairie is now cultivated (crops - rice and tame forage, alfalfa, and tame grasses). Hunting, fishing, and trapping also are principal uses of this type.

Class 2 - The Everglades characterizes this productivity class. Herbage yields average 8,000 to 9,000 pounds per acre. However, most of that is Jamaica sawgrass, a species of little to no value for grazing by cattle. About 10 percent of this type has been converted to domestic pasture which yields approximately 8,000 pounds of desirable herbage. Other species in native stands are three awns, Boehmeria cylindrica, tules, and cattails. Woody plants occur in the bayheads, and the most common are sweet bay and red bay.

The soils are mainly Histols (plant residues moderately decomposed or highly decomposed, gently sloping) which are wet organic (muck) soils. About 50 percent of the 7,200 square miles of the area is in Indian reservations, National Parks, and game refuges. Hunting, fishing, and other recreational activities are major uses of much of the areas. About 5 percent is cropland, and 15 percent is in pasture.

Class 3 - The palmetto prairie and northern cordgrass prairie with herbage yield of about 6,000 pounds per acre characterize this productivity class. Little data exist for the northern cordgrass prairie, so this is a broad estimate at best. Most of the area is intensively developed for resorts and recreation. The major species of the palmetto prairie are wiregrass, hair awn muhly, creeping bluestem, and miscellaneous bluestems, and saw palmetto which is a problem species for grazing by cattle.

The soils are mainly Entisols (Psammaquents plus Haplaquads and Quartzipsamments) which are Entisols that have textures of loamy fine sand or coarser that are permanently wet or are seasonally

wet. Alfisols (Ochroquolfs plus Psammaquents) and Spodosols (Haplaquods plus Quartzipsamments) also occur in this area which are sandy soils with mottles of iron manganese compounds. Restricted drainage is a problem.

Most of this area is now used for grazing by cattle. Thirty to 50 percent of the area in pastures have adequate water-control systems and a high carrying capacity. The trend is to more improved pastures. Winter vegetable gardens, citrus fruit and other subtropical fruit orchards are increasing in importance.

Class 4 - The tall graminoid vegetation of the tule marshes in the Sacramento-San Joaquin Valleys and old lakebeds of the Great Salt Lake and other large lakes in Nevada characterizes this productivity class. Little yield data are available. Broad estimates put herbage yields at about 4,000 pounds per acre. The major species are tules (or bulrushes), cattails, and soft flag. Carex spp. occur in places.

The soils were primarily Histosols (plant residues highly decomposed) but are now classified as Entisols (Xerothents plus Durixalfe, Haploxeralfs, Xerofluvents, Palexeralfs, and Haplaquolls) due to extensive draining and the use of the soil for irrigated cropland. Very little of the tule marshes remain. Those that do are in high demand for places to hunt ducks and geese. Most of the area is now farmed. Important crops are asparagus, sugar beets, potatoes, corn and other grains, and hay within the protecting levee systems which protect the areas against flooding.

HERBAGE PRODUCTION - **Wet Grasslands (41)**

Class	Herbage Production (lbs./Acre)
1	9,000 - 12,000
2	6,000 - 9,000
3	3,000 - 6,000
4	0 - 3,000

No. 42 - ANNUAL GRASSLANDS

Physiography - The California steppe (often referred to as the California annual or foothill grasslands) occupies extensive areas in the Central Valley of California and along the Pacific Coast. They form a discontinuous zone between the upper limits of the valley floors and the Western Hardwoods Ecosystem which occurs mainly between 500 and 2,000 feet above sea level. The Sierra-Cascade Range is on the East and the California Coast Ranges are on the West. The California steppe occupies the lower foothills of these ranges. The foothills are described as rolling hills with numerous level valleys interspersed. Consequently, these lands are the result of colluvial material from the mountain ranges and alluvial material fans. The alluvial and colluvial material flow is much stronger from the Sierra-Cascade Range on the East; consequently, the accumulation is much greater and more extensive on the eastern side of the California valley than on the western side (more obvious in the San Joaquin Valley than in the Sacramento Valley). Numerous small springs and seeps occur throughout the area with the soil-water level close to the surface in the bottoms of valley (ravines).

Climate - Most of the Annual Grasslands Ecosystem has a mile (250-300 days frost-free) climate with hot, dry summers and mild, relatively moist winters. Precipitation ranges from less than 10 inches at low elevation in the southern portion to over 40 inches at the higher elevation at the northern border. Little rain falls in the summer; up to three-fourths of the annual precipitation may fall in the December-March period. Evaporation during the warm season is often many times the precipitation. These climatic conditions are extremely favorable for cool season annuals, which make up practically all the herbage resource.

Vegetation - The vegetation is of grass-life form. Annual grasses (most are considered introduced) now dominate the cover. The dominant species are: wild oats, several species of brome, wild barley, and fescue. Perennial bunch grasses, where they occur, include Stipas, creeping wildrye, and pine bluegrass. Perennials are scarce or absent at lower elevations and increase at the upper elevations of the ecosystem. Forbs, with the exception of filaree, are of secondary importance but the number occurring is large. Many people believe the prehistoric vegetation was perennial but historical evidence is meager and reconstruction of the original perennial vegetation (if it were perennial), if it can be done at all, is accomplished only with complete protection and considerable effort, The earliest references (early 1800's) indicate the California steppe was dominated by annual grasses. The annual plant type, as might be expected, has shown probably the most consistent and profitable response to range fertilization proctices of any range type.

Fauna - Intensive agricultural development has changed the fauna of the annual grassland area; many species have been eliminated or "moved up in the hills." The California grizzly, wolf, and pronghorn have long since disappeared and the San Joaquin kit fox is classified as an endangered species. Several species of mule deer occur in areas with brush. The California quail is now numerous mainly in areas where brush or rock outcrops provide cover. The mourning dove occurs throughout the area. Common mammals include the Beechy ground squirrel, cottontail and blacktailed jackrabbit, and a number of mice, kangaroo rats, etc. Many species occur in or enter from the adjacent woodlands such as the coyote and bobcat. Common birds include the horned lark, western meadowlark, western kingbird, mockingbird, loggerhead shrike, house finch, lesser goldfinch, red-shafted flicker, and scrub jay. The rattlesnake is an important predator on rodents, and the roadrunner feeds partly on reptiles. Avian predators include the golden eagle, red-tailed hawk, and Cooper's hawk. A number of snakes and lizards are present. Other species that occur are listed under the Western Hardwoods Ecosystem.

Soils - Of the three soil orders found in the Annual Grassland Ecosystem, the Entisols and Alfisols cover most of the area. In general, the Entisols are at the lower elevations of the great central valley of California, and the Alfisols occur at slightly higher elevations away from the valley floor. A small area of Aridisol occurs in the more arid southern portion of the San Joaquin Valley.

Productivity Classes

A brief introductory explanation is needed before going into the productivity classes to point out that herbage production is greater on the northern compared to the southern annual ranges of California. This is due mainly to higher precipitation. However, the breakdown into various productivity classes (based on site class) remains basically the same. The herbage yields reported herein are based mostly on research at the San Joaquin Experimental Range (Forest Service) in the Sierra-Nevada foothills 25 miles north of Fresno, California, which is considered in the southern part. It also must be realized that these ranges are very responsive to rainfall which varies considerably and can cause well over 100 percent variation in herbage production from year to year.

The lower elevations of what was the annual grasslands are mostly irrigated and make up the bulk of one of the richest agricultural areas in the world - the great Central Valley of California. At slightly higher elevations, some is dry-farmed, but the area is mostly used for grazing by cattle. The area receives very heavy recreational pressure from the nearby metropolitan areas, such as Los Angeles and San Francisco.

Class 1 - The vegetation of the swales (site class) characterizes this productivity class with average herbage yield of 4,400 pounds per acre. The swales comprise roughly 10 to 15 percent of these grasslands. The dominant species in the site class are foxtail fescue, Mediterranean barley, clovers, filaree, and rushes. However, considerable fluctuation in species composition may occur rapidly as a result of climatic fluctuation. This site is probably more stable than the other sites in this ecosystem as based on the vegetation now present and usually receives intense grazing use.

The soils are mainly Entisols (dark gray, sandy clay loams with fairly good waterholding capacity, better than those of the slopes). The swales receive a considerable amount of seepage water to the point of being saturated in wet winters.

Class 2 - The vegetation on the gentle slopes characterizes this productivity class, producing 2,600 to 3,000 pounds of herbage per acre. The vegetation of this site class occupies the area just above the swale and is on a slope of 10 percent or less. This site class makes up about 10 percent of the California steppe. The dominant species are foxtail fescue, soft chess, mediterranean barley, and clovers in the southern part with wild oats becoming dominant in the northern part. This site, along with the swales, usually receives the hardest use.

The soils are Alfisols and Entisols (Xerorthents), fine sandy loams that represent the transition from transported soils in the swales to soils developed in place on the slopes.

Class 3 - The open, rolling upland sites with herbage production averaging 1,850 pounds per acre represent this productivity class. These sites are located on slopes with gradients of 10 to 25 percent and have a very open cover of trees and only scattered rock outcrops. Dominant species are soft chess, foxtail fescue, filaree, and clovers.

The soils are mainly Alfisols and Entisols (Xerothents that are sandy loams about 24 inches deep).

Class 4 - The vegetation type classed as that on the rocky, brushy rolling to steep slope sites with average herbage yield of 1,000 pounds per acre characterizes this productivity class. These sites have slope gradients of 25 percent or greater and have numerous rock outcrops or many shrubs and trees. They differ considerably from place to place, including some productive soils, as well as some thin sandy soils. This site class makes up 60 to 75 percent of the California steppe. The dominant species are red brome, soft chess, and filaree.

The soils are Alfisols (Haploxeralfs plus Xerothents, shallow that are moderately sloping to steep).

HERBAGE PRODUCTION - Annual Grasslands (42)

Class	Herbage Production (lbs./Acre)
1	3,300 - 4,400
2	2,200 - 3,300
3	1,100 - 2,200
4	0 - 1,100

No. 43 - HAWAIIAN GRASSLANDS

Physiography - Islands of the Hawaiian group are a series of high submarine mountain peaks extending above the ocean surface. They appear above sea level as coastal plains with low and high mountains. Higher mountains rise to an elevation of near 14,000 feet. The Hawaiian grassland ecosystem is found on various topographic features from the relatively flat lowlands to high mountain slopes and ridges. Ranching seldom goes beyond 8,000 feet elevation; however, the grassland communities extend well above this elevation.

Climate - The Hawaiian Islands lie just in the equatorial zone. Prevailing winds are moisture laden northeast trades. Precipitation is highly varied, depending on exposure to the trade winds and elevation. On some windward slopes rainfall induced by orographic uplift of marine air, exceeds 200 inches per year while on the lee side the annual rainfall may not exceed 10 inches. In the lowlands the temperature range between seasons and the daily fluctuation is very narrow. Maximum temperatures vary from 72° to 98° F.; the minimum is from 44° to 70° F. Cooler temperatures are encountered as elevation is gained with frost and snow occurring at higher elevations. Records of sunshine show 2,000 to 2,600 hours per year.

Vegetation - The present vegetation of the Hawaiian Islands has developed in a tropical marine climate from an indigenous and introduced flora. Two-thirds of the species growing on the islands have been introduced. This vegetation is still in a highly dynamic condition. As a result of the varied habitat sites on the mountainous islands, the vegetation has developed into distinct zones. Vegetation zones are determined largely by topographic position which includes elevation and exposure to the trade winds. The windward slopes are very humid while those of the lee side are dry. Students of vegetation have designated the floristic areas as pluvio-tropical (humid) and xero-tropical (dry). The floristic areas are divided into four pluvio-tropical and three xero-tropical zones. The Hawaiian grasslands are found in both of the floristic areas.

Fauna - The native animals of Hawaii are among the most unique, albeit limited faunas in the world, strongly represented by such groups as birds, mollusks, and insects but with a very poor representation of mammals. The monk seal and the hoary bat are the only native mammals. A check list of birds lists 69 native species; native insects and mollusks number in the thousands. Mammals that have been introduced and have become wild are cattle, goats, hogs, sheep, rats, rabbits, mongooses, dogs and cats. Blacktail deer, wallaby, bison, antelope, and axis deer have also been introduced.

Rare and Endangered Species - In the 200 years since the first visit by Europeans to the Hawaiian Islands more plants and animals have become extinct or reduced to rare species than the rest of the United States. Native species threatened with extinction include the two mammals, five fresh water fish, half (500) of the land mollusks; one-fourth (1,500) of the insects, 300 species of flowering plant, and 60 percent of the birds.

Soils - Soils of the Hawaiian Islands consist mainly of Ultisols, Oxisols, and Inceptisols. The Ultisols develop where rainfall is high throughout the season and are used for cultivation and forests. Oxisols consist of Orthox where moist conditions prevail and Ustox on continuously dry sites. These soils are also used for cultivation and pasture. Inceptisols are common on the slopes and are mostly in woods and pasture. A large area of miscellaneous soil types (unclassified) makes up the central portion of the Island of Hawaii.

Productivity Classes

Productivity of the Hawaiian grasslands ecosystem depends to a large degree on the amount of precipitation. However, other factors such as soils and position on the slopes contribute to productivity. Xeric communities on the lee side of the mountains are not as productive as those on the humid windward side. Some of the higher peaks are mostly barren and dry because they extend above the clouds or the clouds go around rather than over them. Areas where clouds hang almost perpetually lack sunshine; thus, the vegetation and productivity are altered.

Class 1 - Productivity class 1 includes the portion of the "Grassland, microphyllous shrub and barren" type that has adequate moisture for high forage production plus the Lama-Manele type. The "Grassland, microphyllous shrub and barren" is the area extending above the forest and may start as low as 2,000 feet elevation or it may be above the 8,000-foot upper limit of the forest zone. This type is characterized by grass and low shrubs and trees. Dominant species are Deschampsia spp, plus two endemic shrubs. Other grasses and shrubs as well as ferns are common in this type. Paspalum conjugatum is one of the common grasses on the area above the forest zones. The Lama-Manele Forest is found on the dissected plateau area between the mountain chains on the Island of Oahu. This type is characterized by two endemic tree species in Kuchler's classification.

Herbage production _____

Forage production _____

Physiognomy _____

Class 2 - This productivity class includes areas of moderate production with the two types described in productivity class 1. Herbage production is _____ to _____ pounds per acre. Forage production is _____ to _____ pounds per acre.

Class 3 - This productivity class includes most of the "sclerophylous forest scrublands and grassland" type. The type is associated with the drier (arid lands) portion of the Hawaiian Islands. Annual precipitation is from 10 to 50 inches. Within this broad type are the prosopis forest on the flats and grass and xeric shrubs on the slopes. Prosopis forests consist of closely spaced trees generally from 30 to 40 feet in height and generally with an understory of forbs and annual grass. The pods of the prosopis are eaten by cattle and may be the only feed available during the dry season. Prosopis is an introduced species that has invaded much of the dry lowlands and xeric flats. There are open grasslands with many indigenous and exotic species. Brushy species occupy large areas. These are mainly leucaena, Lantana, Psidium and Opuntia which have been introduced. Herbage production of this productivity class is from _____ to _____ pounds per acre. Forage production is from _____ to _____ pounds per acre.

Class 4 - Productivity class 0-25 percent includes the drier and more barren portions of "schlerophylous forest scrubland and grassland" and the "grassland, microphylous shrubs and barren." Productivity is from _____ to _____. Forage production varies from _____ to _____.

Land Use

Much of the lowlands portion of the Hawaiian Islands has been converted to the production of cultivated crops, initially by Polynesian settlers and more extensively since 1800. Sugar cane and pineapple are the two principal crops.

Cattle ranching is an important land use on the intermediate and higher slopes. Many acres of pasture have been developed in areas that were formerly rain forest. In the drier areas, other than grass, Leucaena is an extremely important forage plant.

Upland areas of moderate and high rainfall are considered extremely important for watershed values, both as a source of water and because of the potential for flood runoff.

No. 44 - ALPINE

Physiography - The alpine ecosystem occurs largely as an interrupted chain of stands on the highest peaks in the Rocky Mountain and Pacific Mountain systems. Valley glaciers have sculptured most alpine areas and provided spectacular landscapes. Cirques, hanging tributaries, and various types of moraines are common.

Climate - The climate is rigorous. The average monthly temperature may be as low as 3°C. in January and 50°C. in July. Frost may occur any night during the summer. Annual precipitation is estimated to be 35-50 inches per year, falling mostly as snow. Evaporation and wind movement are marked.

Vegetation - The grass life form predominates, but the number of subdominant forbs is very large. Willows may occur on the moist soils of protected slopes and valleys.

Fauna - The pika, pocket gopher, and yellow-bellied marmot are the only permanent mammalian residents of the alpine. Summer visitors include mule deer, elk, mountain sheep, weasels, marten, chipmunk, and golden-manteled ground squirrel. Nesting birds are restricted to the horned lark, water pipit, black rosy finch, rock wren, white-tailed ptarmigan, and robin.

Soils - Soils commonly have no pedogenic horizons (Entisols); weakly differentiated horizons (Inceptisols); or low-base supplies and an accumulation of amorphous materials in subsurface horizons (Spodosols). These cold soils normally belong in the cryic great groups.

Productivity Classes

Class 1 - This production class characterizes microtopography where moisture tends to accumulate. Sedges and tufted hairgrass are characteristic dominants. Willows may form an overstory. Herbage production ranges from 900 to 1,200 pounds per acre. Eighty to 100 percent of the herbage could be considered to be forage, but only 40-50 percent should be used by grazing animals. Soils are normally members of the "Aqu" suborders; seasonally wet, they have mottles or gray colors.

Class 2 - Upper and lower slopes fall within this production class. Dominant species include kobresia, sedges, and alpine avens, tufted hairgrass, and American bistort. Herbage production is about 600-900 pounds per acre, of which 40 percent could be used as forage. Soils range from Inceptisols on the upper slopes to Spodosols on the lower slopes.

Class 3 - This production class is found, generally, on ridge tops and convex land surfaces. The characteristic dominant plants include alpine avens, sedge, dryas and moss silene, and clovers. Herbage production ranges from 300-600 pounds per acre. No more than 10-15 percent of the herbage could be used for forage. Soils are often shallow, stony, and coarse-textured. Pedogenic horizons are absent or weakly developed.

Class 4 - This production class occurs on the shallowest soils of the fellfield and the boulderfield. It may occasionally include wet areas where intensive frost action is taking place.

Dominant species of the boulderfield are lomatium, mountain sorrel, bluebell, sedge, and alpine avens. The dominant species of the fellfield would include such pulvinate species as alpine clover, Rocky Mountain railwood, and moss silene. Other species are sedge.

Herbage production in this production class will vary from a few scatter plants up to 300 pounds per acre. Forage is quite limited, but sheep will wander into the rockfield during dry years to find such lush forage as bluebell.

Land Use

Most of the land is owned by the Federal Government. The ecosystem provides some summer grazing for sheep, but wildlife habitat, recreation, and watershed are the principal uses.

HERBAGE PRODUCTION - Alpine (44)

Class	Herbage Production (lbs./Acre)
1	900 - 1,200
2	600 - 900
3	300 - 600
4	0 300

NO. 49 - DESERT

Physiography - The desert ecosystem is found on the salt flats and playas of the Intermountain region. More than 80 percent of the area is gently sloping; local relief is 100-300 feet.

Climate - The climate is arid. Annual precipitation is less than 8 inches, but the ecosystem receives the drainage from surrounding ecosystems. Temperatures are extreme. In the average year 50-60 days have a maximum temperature of over 90° F; 150-180 days have a minimum temperature of 32° or less. The freeze-free period is near 150 days. Mean annual pan evaporation is 60-65 inches.

Vegetation - Vegetation is either absent or very sparse.

Fauna - No significant mammal or bird population.

Soils - Salt predominates. The included soils have no pedogenic horizons; formed in loamy or clayey alluvial deposits; are never moist as long as 3 consecutive months.

Land Use - Largely wasteland; producing none of the traditional commodities or products.

Special Situation

FRES Desert ecosystem includes alpine barrens and other barren areas of extensive size from other ecosystems that are not otherwise accounted for.

Animal Species Referred to in FRES Ecosystem Descriptions

Mammals

	Common Name	Latin Name
Game	Mule deer	Odocoileus hemionus
	Elk or wapiti	Cervus canadensis
E	True elk	Cervus nannodes
	Moose	Alces alces
	White-tailed deer	Odocoileus virginianus
	Woodland caribou	Rangifer caribou
	Mountain caribou	Rangifer arcticus
	Mountain sheep	Ovis canadensis
	Mountain goat	Oreamnos americanus
	Columbian black-tailed deer	Odocoileus hemionus columbianus
	Pronghorn (antelope)	Antilocapra americana
	California grizzly (extinct)	Ursus californicus
	Grizzly	Ursus horribilis
	Black bear	Euarctos americanus
Predators	Mountain lion	Felis concolor
E	Florida panther	Felis concolor coryi
	Coyote	Canis latrans
	Wolverine	Gulo luscus
	Lynx	Lynx canadensis
	Texas red wolf	Canis rufus rufus
	Wolf	Canis lupus
	Bobcat	Lynx rufus
E	Eastern timber wolf	Canis lupus lycaon
	Marten	Martes americana
	Pacific marten	Martes caurina
	Long-tailed weasel	Mustela frevata
	Red fox	Vulpes fulva
	Arctic fox	Alopex lagopus
	Gray fox	Urocyon cinereo
E	San Joaquin kit fox	Vulpes macrotis mutica
	Desert kit fox	Vulpes macrotis
	Striped skunk	Mephitis mephitis
	Spotted skunk	Spilogale gracilis
	Ringtail	Bassariscus astutus
	Raccoon	Procyon lotor
	Badger	Taxidea taxus
	Black-footed ferret	Mustela nigripes
Rodents	Desert woodrat	Neotoma lepida
	Pinyon mouse	Peromyscus truei
	Deer mouse	Peromyscus maniculatus
	Porcupine	Erethizon dorsatum
	Beaver	Castor candensis
	White-footed mouse	Peromyscus leucopus
E	Utah prairie dog	Cynomys parvidens
	Ords kangaroo rat	Dipodomys ordii
	Great basin kangaroo rat	Dipodomys microps
	Kangaroo rats	Dipodomys spp.

	Common Name	Latin Name
	Beechy ground squirrel	Citellus beechyi
	Kangaroo rat	Dipodomys heermanni
	Pocket gopher	Thomomys spp.
	Eastern gray squirrel	Sciurus carolinensis
	Western gray squirrel	Sciurus griseus
	Fox squirrel	Sciurus niger
	Eastern chipmunk	Tamias striatus
Lagomorphs	Black-tailed jackrabbit	Lepus californicus
	Snowshoe rabbit	Lepus americanus
	Pygmy cottontail	Sylvilagus idahoensis
	Desert cottontail	Sylvilagus audobonii
	Nuttall's cottontail	Sylvilagus nutallii
	Eastern cottontail	Sylvilagus floridanus
	White-tailed jackrabbit	Lepus townsendii
	Pika or cony	Ochotona princeps
	Arctic hare	Lepus arcticus
	Opossum	Didelphis marsupialis
Miscellaneous	Bison	Bison bison
	Coatimundi	Nasua narica
	Armadillo	Dasypus novemcinctus
Rodents	Desert kangaroo rat	Dipodomys deserti
	Merriam's kangaroo rat	Dipodomys merriami
	Pale kangaroo mouse	Microdipodops pallidus
	Little pocket mouse	Perognathus longimembris
	Cactus mouse	Peromyscus erimicus
	Long-tailed pocket mouse	Perognathus formosus
	Antelope ground squirrel	Citellus leucurus
	Cotton mouse	Peromyseus gossypinus
	Pocket gopher	Thomomys spp.
	Cotton rat	Sigmodon hispidus
	Hoary marmot	Marmota caligata
	Yellow-bellied marmot	Marmota flaviventris
	Woodchuck	Marmota monax
	Golden-manteled ground squirrel	Citellus lateralis
	Bushy-tailed woodrat	Neotoma cinerea
	Douglas squirrel	Tamiasciurus douglasii
	Townsend's chipmunk	Eutamias townsendii
	Red douglas squirrel	Tamiasciurus hudsonicus
	Meadow jumping mouse	Zapus hudsonicus
Game E	Sonoran pronghorn	Antilocapra americana sonoriensis
	Peccary or javelina	Pecari tajaco
E	Key deer	Odocoileus virginianus clavicum
	Coves or Arizona white-tailed deer	Odocoileus virginianus covesi
	Sitka mule deer	Odocoileus hemionus sitkensis
	Brown or Kodiak bear	Ursus middendorfii
E	Monk seal	Monachus schauinslandi
Miscellaneous	Short-tailed shrew	Blarina brevicauda
	Pine vole	Microtus pinetorum
	Coast mole	Scapanus orarius

Reptiles

Common Name	Latin Name
Horned lizard	Phrynosoma spp.
Collared lizard	Crotaphytus collaris
Great Basin rattlesnake	Crotalus viridis
Sagebrush swift	Sceloporus graciosus
Gila monster	Heloderma suspectum
Timber rattlesnake	Crotalus horridus
Garter snake	Thamnopsis sirtalis
Box turtle	Terepene ornata
American alligator	Alligator mississippiensis
Diamondback rattlesnake	Crotalus adamanteus
Copperhead	Agkistrodon contortrix

Birds

	Common Name	Latin Name
Game	Spruce grouse	Canachites spp.
	Blue grouse	Denragapus spp.
	Ruffed grouse	Bonasa umbellus
	Band-tailed pigeon	Columba fasciata
	Wild turkey	Meleagris gallopavo
	Bobwhite	Colinus virginianus
	Mourning dove	Zenaidura macroura
	California quail	Lophortyx californicus
	Mountain quail	Oreortyx pictus
	Scaled quail	Callipepla squamata
	Gambel's quail	Lophortyx gambelii
	White-winged dove	Zenaida asiatica
	Lesser prairie chicken	Tympanuchus pallidicinctus
	Sharp-tail grouse	Pedioccetes phasianellus
Predator	Red-tailed hawk	Buteo jamaicensis
	Golden eagle	Aquila chrysaetos
	Screech owl	Otus asio
	Great horned owl	Bubo virginianus
	Sharp-shinned hawk	Accipiter striatus
	Cooper's hawk	Accipiter cooperii
	California condor	Gymnogyps californicus
E	Southern bald eagle	Haliaectus leucocephalus
	Ferruginous hawk	Buteo regalis
	Pigmy owl	Glaucidium gnoma
	Rock ptarmigan	Lagopus mutus
	Willow ptarmigan	Lagopus lagopus
	Sage grouse	Centrocercus urophasianus
	Greater prairie chicken	Tymphanuchus cupido
R	Northern greater prairie chicken	Tymphanuchus cupido pinnatus
E	Attwater's prairie chicken	Tymphanuchus cupido attwateri
	White-tailed ptarmigan	Lagopus leucurus
Miscellaneous	Plain titmouse	Parus inornatus
&	Tufted titmouse	Parus bicolor
Song	Scrub jay	Aphelocoma coerulescens
	Pinyon jay	Gymnorhinus cyanocephela
	Stellar's jay	Cyanocitta stellari
	Gray jay	Perisoreus canadensis
	Common bushtit	Psaltiparus minimus
	Pileated woodpecker	Dryocopus pileatus
	Brown creeper	Certhia familiaris
	Hermit warbler	Dendroica occidentalis
	Red crossbill	Loxia curvirostra
	Yellow-shafted flicker	Coleoptes auratus
E	Kirtland's warbler	Dendroica kirtlandii
	Magnolia warbler	Dendroica magnolia

	Common Name	Latin Name
	Common nighthawk	Chordeiles minor
	Loggerhead shrike	Lanius ludovicianus
	Mockingbird	Mimus polyglottus
	Western kingbird	Tyrannus verticalis
	House finch	Carpodacus mexicanus
	American goldfinch	Spinus tristis
	Lesser goldfinch	Spinus psaltria
	Red-shafted flicker	Colaptes cafer
	Roadrunner	Geococcyx californianus
	Gila woodpecker	Centurus uropygialis
	Purple martin	Progne subis
	Chachalaca	Ortalis vetula
	Blue jay	Cyannocitta cristata
	Downy woodpecker	Dendrocopus pubescens
	Hairy woodpecker	Dendrocopus villosus
	Western wood pewee	Contopus sordidulus
	Eastern wood pewee	Contopus virens
	Wood thrush	Hylocichla mustelina
	Scarlet tanager	Piranga olivacea
	Summer tanager	Piranga rubra
	Lark sparrow	Chowdestes grammacus
	Yellow-billed cuckoo	Coccyzus americanus
	Red-eyed vireo	Vireo olivaceous
	Ovenbird	Seiurus aurocapillus
E	Ivory-billed woodpecker	Campephilus principalis
	Mangrove cuckoo	Coccyzus minor
	Golden-fronted woodpecker	Centurus aurifrons
	Robin	Turdus migratorius
	Horned lark	Eremophila alpestris
	Western meadowlark	Sturnella neglecta
	Lark bunting	Calamospiza melanocorys
E	Whooping crane	Grus americana
E	Everglades kite	Rhostramnus sociabilis plumbeus
R	Florida great white heron	Ardea occidentalis
	Black rosy finch	Leucosticte atrata
	Brown creeper	Certhia familiaris
	Water pipit	Anthus spinoletta
	Rock wren	Salpinctes obsoletus
	Common raven	Corvus corvax
	Oregon junco	Junco oreganus
	Pine siskin	Spinus pinus
	Red-breasted nuthatch	Sitta canadensis
	Chestnut-backed chickadee	Parus rufescens
	Cardinal	Richmondena cardinalis
	Carolina wren	Thryothorus ludovicianus
	Ruby-throated hummingbird	Archilochus colubris
	Catbird	Dumetella carolinensis
	Indigo bunting	Passerina cyanea

Common Name	Latin Name
Common crow	Corvus brachyrhynchos
Hermit thrush	Hylocichla guttata
Black-capped chickadee	Parus atricapillus
Swainson's thrush	Hylocichla ustulata
Wood duck	Aix sponsa

Selected References for FRES Ecosystem Descriptions

Anonymous, 1969. A forest atlas of the South. U. S. Dept. Agri., Forest Service. 27 p.

Austin, M. E., 1965. Land resource regions and major land resource areas of the United States. S.C.S., U.S.D.A. Agri. Handbook 296. 82 p.

Braun, E. L., 1950. Deciduous forests of eastern North America. Philadelphia, Penn. Blakiston Co.

Clements, F. E. and J. E. Weaver, 1938. Plant ecology. McGraw-Hill, New York. 601 p.

Fenneman, N. M., 1931. Physiography of western United States. McGraw-Hill, New York. 534 p.

Fenneman, N. M., 1938. Physiography of eastern United States. McGraw-Hill, New York. 714 p.

Kuchler, A. W., 1964. Manual to accompany the map Potential Natural Vegetation of the conterminous United States. Amer. Geographical Soc. Special Publ. No. 36. 38 p.

Lull, Howard W., 1968. A forest atlas of the Northeast. U. S. Dept. Agri., Forest Service. 46 p.

Miller, D. W., J. J. Geraghty, and R. S. Collins, 1962. Water atlas of the United States. Water Information Center, Inc., Port Washington, N. Y.

Shelford, V. E., 1963. The ecology of North America. Univ. Illinois Press, Urbana. 610 p.

U. S. Geological Survey, 1967. Potential Natural Vegetation. National Atlas Sheet No. 90.

U. S. Geological Survey, 1969. Classes of land-surface form. National Atlas Sheet Number 62.

U. S. Geological Survey, 1969. Distribution of principal kinds of soils: orders, suborders, and great groups. National Atlas Sheet No. 86.

U. S. Geological Survey, 1969. Major forest types. National Atlas Sheet No. 182.

U. S. Geological Survey, 1969. Potential Natural Vegetation of Alaska. National Atlas Sheet Number 89.

U. S. Geological Survey, 1969. Soils in the United States. National Atlas Sheet Number 85.

Visher, S. S., 1954. Climatic atlas of the United States. Harvard Univ. Press, Cambridge. 403 p.

Literature References

Sagebrush

Beetle, A. A.
1960. A study of sagebrush. The section tridentatae of artemisia. Wyo. Agri. Exp. Sta. Bull. 367.

Fosberg, M. A. and M. Hironaka
1964. Soil properties affecting the distribution of big and low sagebrush communities in southern Idaho. Amer. Soc. Agron. Spec. Pub. 5:230-236.

Tisdale, E. W., M. Hironaka, and M. A. Fosberg
1965. An area of pristine vegetation in Craters of the Moon National Monument, Idaho. Ecol. 46:349-352.

Tisdale, E. W., M. Hironaka, and M. A. Fosberg
1969. The sagebrush region in Idaho - a problem in range resource management. Idaho Agri. Exp. Sta. Bull. 512 - University of Idaho 15 pp. illus.

Desert Shrubs

Bleak, A. T. and N. C. Frischknecht
1965. Problems in artificial and natural revegetation of the arid shadscale vegetation zone of Utah and Nevada. Jour. Range Mgt. 18:59-65.

Turner, Raymond M., Stanley M. Alcorn, and George Olin
1969. Mortality of transplanted saguaro seedlings. Ecol. 50:835-844.

West, Neal E. and Kamal J. Ibrehim
1968. Soil-vegetation relationships in the shadscale zone of southeastern Utah. Ecol. 49:445-456

Literature References

Desert Shrub

Cable, Dwight R. and Fred H. Tschirley.
1961. Responses of native and introduced grasses following aerial spraying of velvet mesquite in So. Ariz. Jour. Rg. Mgt. 14:155-159.

Darrow, Robert A.
19 . Arizona Range Resources and Their Utilization I. Cochise Co. Tech. Bull. 103 Univ. of Ariz. Agr. Exp. Sta.

Reynolds, Hudson G. and S. Clark Martin
1968. Managing grass-shrub cattle ranges in the southwest. U. S. Dept. Agr. For. Serv. Agr. Handbook No. 162.

Rosenzweig, Michael L. and Jerald Winakur.
1969. Population ecology of desert rodent communities: Habitats and Environmental Complexity. Ecol. 50:558-572.

Schmutz, Ervin M., Dwight R. Cable, and John J. Warwick.
1959. Effect of shrub removal on the vegetation of a semidesert grass-shrub range. Jour. of Rg. Mgt. 12:34-37.

Literature References

Hawaiian Grasslands & Forest

Britten, E. J.
1959. Volcano Ranching: Problems and Opportunities in management of Hawaiian Rangelands.
Jour. Range Mgt. 6:303-306.

1970. Papers given at Colloquium on Endangered Species of Hawaii - Pocket from Robert E. Buchman, Assistant to Deputy Chief, Research, Forest Service
1. Statement of purpose and preamble
2. Agenda
3. List of rare and endangered, possibly extinct, species of insects and related arthropods in Hawaiian Archipelago. Compiled by Wayne Gagne, G. Allan Samuelson, and S. Nakatr.
4. Endangered wildlife of Hawaii complied by Henry H. Goodwin.
5. Preliminary list of rare, threatened, and probably extinct species of Hawaiian flowering plants by F. R. Fosberg.
6. Hawaii's endangered birds - A status appraisal. by Winston E. Banko.
7. Extinct land molluscan species by Yoshio Kondo.

Carlson, N. K.
1952. Grazing land problems, Molokai Island, Territory of Hawaii.
Journal of Range Management 5(4):230-242.

Egler, Frank E.
1939. Vegetation zones of Oahu, Hawaii.
Empire Forestry Journal 18(1):14 pp.

Egler, Frank E.
1947. Arid southeast Oahu vegetation, Hawaii.
Ecol. Manog. 17:383-435.

Fosberg, F. R.
1942. Uses of Hawaiian ferns.
Am. Fern Jour. 32:15-23.

Fosberg, F. R.
1951. The American elements of Hawaiian flora.
Pacific Science 5(2):204-206

Hall, William L.
1904. The Forests of the Hawaiian Islands.
Bureau of Forestry Bull. No. 48 29 pp. illus.

Hosaka, Edward Y.
1937. Ecological and Floristic Studies in Kipapa Gulch, Oahu.
Occasional papers of Bernice P. Bishop Museum, Honolulu, Hawaii, 132(17):177-231.

Krauss, F. G., C. S. Judd, et al
1927. Hawaiian Forest areas.
Agr. Studies No. 1, Univ. of Hawaii, Honolulu.

Nelson, Robert E.
1967. Records and maps of forest types in Hawaii.
Berkeley, Calif. Pacific SW For. & Range Exp. Sta.
For. Serv. Res. Bull. PSW-8, 22 pp.

Literature References

Hemlock-Sitka Spruce

Franklin, J. F. and C. T. Dryness
1969. Vegetation of Oregon and Washington.
Forest Service Research Paper PNW-80

Douglas Fir

Daniel, T. W. and M. E. Ensminger.
1945. Grazing on cutover lands of western Washington.
State College of Washington, Pullman, Wash.
Agr. Exp. Sta. Popular Bulletin No. 179.

Franklin, J. F. and C. T. Dryness
1969. Vegetation of Oregon and Washington
U.S.D.A. Forest Service Research Paper PNW-80.

Reid, E. H., L. A. Isaac, and G. D. Pickford
1938. Plant succession on a cutover, burned, and grazing Douglas fir area. Pac. N.W. Forest & Range Exp. Sta. Research Note No. 26.

Mountain Meadows

Crane, B. K.
1950. Condition and grazing capacity of wet meadows on the east slope of the Sierra-Nevada Mountains.
Journal of Range Management 3(4):303-307.

Pickford, G. D. and E. H. Reid
1942. Guides to determine range condition and proper use of mountain meadows in eastern Oregon.
Pac. N.W. Forest & Range Exp. Sta. Range Research Rept. No. 3
20 pp.

Saunderson, H. R.
1967. Herbage production on high Sierra-Nevada meadows.
Jour. Range Mgt. 20(4):255-256.

Literature References

Mountain Grasslands

Costello, D. F. 1954.
Vegetation zones in Colorado. (From introduction to H. D. Harrington's The Manual of the Higher Plants of Colorado, Sage Book Co., Denver, Colo.)

Daubenmire, R. F. 1942.
An ecological study of the vegetation of southeastern Washington and adjacent Idaho. Ecological Monographs 12:January, p. 53-79.

Hurd, Richard M. 1961.
Grassland vegetation in the Bighorn Mountains, Wyoming. Ecology 42:(3) 459-467.

Johnson, W. M. 1962.
Vegetation of high altitude ranges in Wyoming as related to use by game and domestic sheep. Univ. of Wyoming Agr. Exp. Sta. Bull. 387.

Mueggler, W. F. and C. A. Harris. 1969.
Some soil and vegetation characteristics of mountain grasslands in central Idaho. Ecology 50(4):671-678.

Pickford, G. D. and E. H. Reid. 1942.
Basis for judging subalpine grassland ranges of Oregon and Washington. U.S.D.A. Circular No. 655 37 pp.

Pickford, G. D. and E. H. Reid. 1948.
Forage utilization on summer cattle ranges in eastern Oregon. U.S.D.A. Circular 796.

Strickler, Gerald S. 1961.
Vegetation and soil condition changes on subalpine grassland in eastern Oregon. Pac. N.W. Forest & Range Exp. Sta. Research Paper No. 40.

Literature References

Ponderosa Pine

Costello, D. F. and H. E. Schwann. 1946.
Conditions and trends on ponderosa pine ranges in Colorado.
U.S.D.A. Forest Service Rocky Mtn. Forest & Range Exp. Sta.
& Rocky Mtn. Regional Office.

Garrison, G. A. 1964.
Changing conditions in northwest forested ranges.
Proceedings Soc. Amer. Foresters, Denver, Colo.

Garrison, G. A. 1968.
Challenge of forest grazing in Pacific Northwest.
Abstracts American Society of Range Management, Calgary, Canada.

Pearson, H. A. and D. A. Jameson. 1967.
Relationship between timber and cattle production on ponderosa pine range: the Wild Bill Range.
U.S.D.A. Forest Service Rocky Mtn. Forest & Range Exp. Sta.

Pickford, G. D. & E. H. Reid. 1948.
Forage utilization on summer cattle ranges in eastern Oregon.
U.S.D.A. Circular 796.

Reid, E. H. 1947.
Forest grazing in the Pacific Northwest.
Proceedings Soc. of Amer. Foresters.

Reid, E. H. 1964.
Forage production in ponderosa pine forests.
Proceedings Soc. Amer. Foresters, Denver, Colorado.

Rummell, R. S. 1951.
Some effects of livestock grazing on ponderosa pine forest and range in central Washington.
Ecology 32(4):594-607.

Literature References

Alpine

Forest Service. 1958. Timber resources for America's future. Forest Resource Report No. 14, 713 p.

Johnson, P. L. and W. D. Billings. 1962. The alpine vegetation of the Beartooth Plateau in relation to cryopedogenic processes and patterns. Ecol. Monog. 32:105-135.

Paulsen, H. A., Jr. 1960. Plant cover and foliage use of alpine sheep ranges in the central Rocky Mountains. Iowa State College J. Sci. 34:731-748.

Smith, D. R. 1969. Vegetation, soils, and their interrelationships at timberline in the Medicine Bow Mountains, Wyoming. Wyo. Agri. Exp. Sta. Sci. Monog. 17, 13 p.

Literature References

Texas Savanna

Box, T. W. 1960. Herbage production in four range plant communities in south Texas. J. Range Mgt. 13:72-76.

Box, T. W. 1961. Relationships between plants and soils of four range communities in south Texas. Ecology 42:794-810.

Fanning, Thompson & Issacs. 1965. Properties of saline range soils of the Rio Grande plain. J. Range Mgt. 18:190-195.

Fenneman, N. M. 1931. Physiography of Western U. S. McGraw-Hill Book Co., Inc., N.Y. 534 pp.

Fenneman, N. M. 1938. Physiography of Eastern U. S. McGraw-Hill Book Co., Inc., N.Y. 714 pp.

Johnston, M. 1963. Past and present grasslands of southern Texas and N.E. Mexico. Ecology 44:456-466.

Kuchler, A. W. 1964. Potential Natural Vegetation of the Conterminous U. S. Manual and Map. American Geographical Society, Broadway at 156th St., N.Y.

McMahan, C. A. & C. W. Ramsey. 1965. Response of deer and livestock to controlled grazing in central Texas. J. Range Mgt. 18:1-7.

Soil Conservation Service. 1967. Distribution of principal kinds of soils: orders, suborders, and great groups - map and text. U. S. Geological Survey, Washington, D. C.

Stoddart, T. A. and A. D. Smith. 1955. Range Management. McGraw-Hill Book Co., Inc., N.Y. 433 pp.

Thomas, G. W. and V. A. Young. 1954. Relation of soils, rainfall, and grazing management to vegetation -- western Edwards Plateau of Texas. Bulletin 786, Texas Agri. Exp. Sta., College Station, Texas.

Thorp. B. C. 1926. Structure of Texas vegetation east of the 98th Meridian, U. of Texas Bulletin No. 2606, U. of Texas, Austin, Texas.

Literature References

Prairie

Aikman, J. M. 1955. Burning in the management of prairie in Iowa. Iowa Acad. Sci. Proc. 62:53-62.

Buttery, R. F. 1960. Grazed glades can grow good grass. Journ. Range Mgt. 13:234-235.

Ehrenreich, J. H. 1959. Effect of burning and clipping on growth of native prairie in Iowa. J. Range Mgt. 12:133-137.

Ehrenreich, J. H. and Aikman. 1963. An ecological study of the effect of certain management practices on native prairie in Iowa. Ecological Monographs 33:113-130.

Hopkins, H. H. 1951. Ecology of the native vegetation of the loess hills in central Nebraska. Ecol. Monog. 21:125-147.

Hulbert, T. C. 1969. Fire and litter effects in undisturbed bluestem prairie in Kansas. Ecology 50:874-877.

Kelting, R. W. 1954. Effects of moderate grazing on the composition and plant production of a native tall-grass prairie in central Oklahoma. Ecology 35:200-207.

Kucera, C. L. and J. H. Ehrenreich. 1962. Some effects of annual burning on central Missouri prairie. Ecology 43:334-336.

Kucera, C. L. and S. C. Martin. 1957. Vegetation and soil relationships in the glade region of the southwestern Missouri Ozarks. Ecology 38:285-291.

Martin, S. C. and J. S. Crosby. 1955. Burning and grazing on glade range in Missouri. Tech. Paper No. 147, Central States Forest Exp. Sta., U.S.D.A. Forest Service, Columbus, Ohio.

Porter, C. L. 1966. An analysis of variation between upland and lowland switchgrass, Panicum virgatum L., in central Oklahoma. Ecology 47:980-992.

Vogel, W. G. and A. J. Bjugstad. 1968. Effects of clipping on yield and tillering of little bluestem, big bluestem, and Indiangrass. Jour. Range Mgt. 21:136-140.

Literature References

Plains Grassland

Bjugstad, A. J. and W. C. Whitman. 1970. Significance of reduced plant vigor in relation to range condition. Jour. Range Mgt. 23:181-184.

Holscher, C. E. and E. J. Woolfolk. 1953. Forage utilization by cattle on Northern Great Plain ranges. U.S.D.A. Cir. 918.

Houston, W. R. 1961. Some interrelations of sagebrush, soils, and grazing intensity in the Northern Great Plains. Ecology 42:31-38.

Larson, F. and W. Whitman. 1942. A comparison of used and unused grassland mesas in the badlands of South Dakota. Ecology 23:438-445.

Reed, M. J. and R. A. Peterson. 1961. Vegetation, soils, and cattle responses to stocking and grazing on Northern Great Plains ranges. U.S.D.A. Tech. Bull. 1252

Smoliak, S. 1956. Influence of climatic conditions on forage production of shortgrass rangeland. Jour. Range Mgt. 9:89-91.

Literature References

Southwestern Shrubsteppe and Desert Grasslands

Cable, D. R. 1969. Competition in the semidesert grass-shrub types as influenced by root systems, growth habits, and soil moisture. Ecology 50:27-38.

Gehlbach, F. R. 1967. Vegetation of the Guadalupe escarpment, New Mexico-Texas. Ecology 48:404-419.

Goebel, C. J. and C. W. Cook. 1960. Effect of range condition on plant vigor, production, and nutritive value of forage. Jour. Range Mgt. 13:307-313.

Humphrey, R. R. 1933. The desert grassland: a history of vegetational changes and an analysis of causes. Botanical Review 24:193-252.

Jameson, D. J. 1962. Effects of burning on a galleta-black grama range invaded by juniper. Ecology 43:760-763.

Leithead, H. L. 1959. Runoff in relation to range condition in the Big Bend-Davis Mountain section of Texas. Jour. Range Mgt. 12:83-87.

Paulsen, H. A. and F. N. Ares. 1961. Trends in carrying capacity and vegetation on an arid southwestern range. Jour. Range Mgt. 14:78-83.

Potter, L. D. and J. C. Krenetsky. 1967. Plant succession with released grazing on New Mexico range lands. Jour. Range Mgt. 20:145-151.

Thomas, G. W. and V. A. Young. 1954. Relation of soils, rainfall, and grazing management to vegetation -- western Edwards Plateau of Texas. Bull. 786, Texas Agri. Exp. Sta., College Sta., Texas.

Whittaker, R. H. and Niering. 1965. Vegetation of the Santa Catalina Mountains, Arizona: A gradient analysis of the south slope. Ecology 46:429-452.

Literature References

Oak-Pine
Longleaf-Slash Pine
Loblolly-Shortleaf Pine

Austin, M. F. 1965. Land resource regions and major land resource areas of the U. S. Agri. Handbook 296 SCS, USDA, Washington, D. C.

Fenneman, N. M. 1931. Physiography of Eastern U. S. Mc-Graw-Hill Book Co., Inc., N.Y., 714 pp.

Gansner, D. A. 1965. Missouri forests. Forest Service Resource Bull. CS-2. Central States Forest Exp. Sta., USDA Forest Service, Columbus, Ohio.

Hottel, J. B. and A. F. Arnold. 1965. Crop, pasture, timber, and livestock enterprises for the Boston Mountain and Ozark Highland areas of Arkansas. Report Series 135. Agri. Exp. Sta., Div. of Agri., U. of Arkansas, Fayettesville, Ark.

Kelsey, H. L. and W. A. Dayton. 1942. Standardized plant names. J. Horace McFarland Co., Harrisburg, Pa., 675 pp.

Nelson, T. C. and W. M. Zillgitt. 1969. A forest atlas of the south. 27 pp. So. Forest Exp. Sta., New Orleans, La.

Society of American Foresters. 1954. Forest cover types of North America. S.A.F., Mills Bldg., Washington, D. C. 69 pp.

Soil Conservation Service. 1967. Distribution of principal kinds of soils; orders, suborders, and great groups - map and text. Geological Survey, Washington, D. C.

Southern Section ASRM. 1955. Range resources of the south. Bull. N.S. 9, Georgia Agri. Exp. Sta., U. of Georgia, 31 pp.

Sternitzke, H. S. 1960. Arkansas forests. Southern Forest Experiment Station, New Orleans, La., 58 pp.

Literature References

Elm-Ash-Cottonwood

Austin, M. F. 1965. Land resource regions and major land resource areas of the U. S. Agri. Handbook 296, SCS, USDA, Washington, D. C.

Beals, E. W. and J. B. Cope. 1964. Vegetation and soils in an eastern Indiana woods. Ecology 45:777-792.

Ganser, D. A. 1965. Missouri forests. Forest Service Resource Bull. CS-2, Central States Forest Exp. Sta., Forest Service, Columbus, Ohio.

Kelsey, H. P. and W. A. Dayton. 1942. Standardized plant names. J. Horace McFarland Co., Harrisburg, Pa., 675 pp.

Kuchler, A. W. 1964. Potential natural vegetation of the conterminous U. S. American Geographical Society, Broadway at 156th St., N. Y.

Society of American Foresters. 1954. Forest cover types of North America. Society of American Foresters, Mills Bldg., Washington, D. C., 69 pp.

Literature References

Shinnery

Allred, B. W. 1949. Distribution and control of several woody plants in Texas and Oklahoma. Jour. Range Mgt. 2:17-29.

Austin, M. E. 1965. Land resource regions and major land resource areas of the U. S. Agri. Handbook 296, USDA, Washington, D. C., 82 pp.

Fenneman, N. M. 1931. Physiography of Western United States. McGraw-Hill Book Co., N.Y., 534 pp.

Lotspeich, F. P. and M. E. Everhart. 1962. Climate and vegetation as soil forming factors on the Llano Estacado. Jour. Range Mgt. 15:134-141.

Shelford, V. E. 1963. The ecology of North America. University of Illinois Press, Urbana, Ill., 610 pp.

Stoddart, L. A. and A. D. Smith. 1955. Range Management. McGraw-Hill Book Co., N.Y., 433 pp.

Weaner, J. E. and F. E. Clements. 1938. Plant Ecology. McGraw-Hill Book Co., Inc., N.Y., 601 pp.

Literature References

Oak-Hickory

Austin, M. E. 1965. Land resource regions and major land resource areas of the U. S. Agri. Handbook 296, USDA, Washington, D. C., pp.

Bazzaz, F. A. 1968. Succession on abandoned fields in the Shawnee Hills, Southern Illinois. Ecology 49:924-936.

Bjugstad, A. J. and H. S. Crawford. 1967. Cattle in the woods or woods in the pasture. Research Note NC-23, North Central Forest Exp. Sta., St. Paul, Minn.

Bjugstad, A. J. and A. V. Dalrymple. 1968. Behavior of beef heifers on Ozark ranges. Mo. Agri. Exp. Sta. Bul. 870, Mo. Agri. Exp. Sta., U. of Mo., Columbia, Missouri.

Bjugstad, A. J., D. A. Murphy, and H. S. Crawford. 1968. Poor returns from Ozark woodland grazing. Research Note NC-60, North Central Forest Exp. Sta., St. Paul, Minn.

Caplenor, D. 1968. Forest composition on loessal and non-loessal soils in west-central Mississippi. Ecology 49:322-331.

Clarkson, R. B. 1966. The vascular flora of the Monongohela National Forest, West Virginia. Castanea 31:1-119.

Crawford, H. S. and R. G. Leonard. 1965. The Sylamon deer study. Proceedings, 17th Annual Conf., pp. 9-13, S.E. Assoc. Game & Fish Comm. 1965.

Crawford, H. S. and A. J. Bjugstad. 1967. Establishing grass range in the southwestern Missouri Ozarks. Reserach Note NC-22, North Central Forest Exp. Sta., St. Paul, Minn.

Davis, A. M. 1967. Rangeland development through brush control in the Arkansas Ozarks, Bulletin 726. Agri. Exp. Sta., Division of Agri., U. of Arkansas, Fayetteville, Ark.

Ehrenreich, J. H. and J. S. Crosby. 1960. Forage production on sprayed and burned areas in the Missouri Ozarks. Jour. Range Mgt. 13:68-69.

Ehrenreich, J. H. and J. S. Crosby. 1960. Herbage production is related to hardwood crown cover. Jour. of Forestry 58:564-565.

Ehrenreich, J. H. and R. A. Ralston. 1963. Forage and timber production alternating on shallow soils in the Ozarks. Proceedings, Soc. American Forestry, Boston, Mass., pp. 80-83.

Halls, L. K. and H. S. Crawford. 1960. Deer-forest habitat relationships in North Arkansas. Jour. of Wildlife Mgt. 24:387-395.

Halls, L. K., R. A. Read, and H. S. Crawford. 1960. Forage and ground-cover conditions in unmanaged Ozark forests. Southern Forest Research 1:1-16, Southern Forest Exp. Sta., New Orleans, La.

Halls, L. K. and H. S. Crawford. 1965. Vegetation response to an Ozark woodland spraying. Jour. Range Mgt. 18:338-340.

Hottel, J. B. and A. F. Arnold. 1965. Crop, pasture, timber, and livestock enterprises for the Boston Mountain and Ozark Highland areas of Arkansas. Report Series 135, Agri. Exp. Sta., Div. of Agri., U. of Arkansas, Fayetteville, Ark.

Hough, A. F. 1965. A twenty-year record of understory vegetation changes in a virgin Pennsylvania forest. Ecology 46:370-373.

Jones, A. S. and E. G. Patton. 1966. Forest, "Prairie," and soils in the Black Belt of Sumter County, Alabama, in 1832. Ecology 47:75-80.

Martin, S. C. 1955. The place of range livestock in the Missouri Ozarks. Jour. Range Mgt. 8:105-111.

Murphy, D. A. and J. H. Ehrenreich. 1965. Effects of timber harvest and stand improvement on forage production. The Jour. of Wildlife Mgt. 29:734-739.

Pearson, P. R. 1962. Increasing importance of sugar maple on two calcareous formations in New Jersey. Ecology 43:711-718.

Ray, H. C. and M. Lawson. 1955. Site characteristics as a guide to forest and grazing use in the Ozarks. Jour. Range Mgt. 8:69-73.

Read, R. A. 1951. Woodland forage in the Arkansas Ozarks. Jour. Range Mgt. 4:391-396.

Sherman, R. W. 1967. Economics of sawtimber production in Appalachia, Ohio. Research Circular 152, Ohio Agri. Res. and Development Center, Wooster, Ohio.

Society of American Foresters. 1954. Forest cover types of North America. S.A.F., Mills Bldg., Pennsylvania Ave., Washington, D. C., 67 pp.

Sternitzke, H. S. 1967. East Texas post oak region. U. S. Forest Service Resource Bull. SO-11, Southern Forest Exp. Sta., Forest Service, New Orleans, La.

Whittaker, R. H. 1962. Net production relations of shrubs in the Great Smoky Mountains. Ecology 43:357-377.

Whittaker, R. H. 1966. Forest dimensions and productions in the Great Smoky Mountains. Ecology 47:103-121.

Literature References

Annual Grassland

Bentley, J. R. and M. W. Talbot. 1951. Efficient use of annual plants on cattle ranges in the California foothills. Circular No. 870, USDA, Washington, D. C., 52 pp.

Bentley, J. R., L. R. Green, and K. A. Wagnon. 1958. Herbage production and grazing capacity on annual-plant range pastures fertilized with sulphur. Jour. Range Mgt. 11:133-140.

Burcham, L. T. 1956. Historical backgrounds of rangeland use in California. Jour. Range Mgt. 9:81-86.

Conrad, C. E., E. J. Woolfolk, and D. A. Duncan. 1966. Fertilization and management implications on California annual-plant range. Jour. Range Mgt. 19:20-26.

Green, L. R., K. A. Wagnon, and J. R. Bently. 1958. Diet and grazing habits of steers on foothill range fertilized with sulphur. Jour. Range Mgt. 11:221-227.

Heady, H. F. 1958. Changes in a California annual plant community type. Ecology 39:402-416.

Heady, H. F. 1961. Continuous vs. specialized grazing systems: A review and application to the California annual type. Jour. Range Mgt. 14:182-193.

Heady, H. F. 1964. Palatability of herbage and animal preference. Jour. Range Mgt. 17:76-82.

Jones, M. B. 1960. Response of annual range to urea applied at various dates. Jour. Range Mgt. 13:188-192.

McNaughton, S. J. 1968. Structure and function in California grasslands. Ecology 49:962-972.

Naveh, Z. 1967. Mediterranean ecosystems and vegetative types in California and Israel. Ecology 48:445-459.

Ratliff, R. A. and H. F. Heady. 1962. Seasonal changes in herbage weight in an annual grass community. Jour. Range Mgt. 15:146-149.

Reppert, J. N., M. J. Morris, and C. A. Graham. 1962. Estimation of herbage on California annual-type range. Jour. Range Mgt. 15:318-323.

Walker, C. F. and W. A. Williams. 1963. Responses of annual-type range vegetation to sulphur-fertilization. Jour. Range Mgt. 16:64-69.

William, W. A., C. M. McKell, and J. N. Reppert. 1964. Sulphur fertilization of an annual-range soil during years of below normal rainfall. Jour. Range Mgt. 17:1-5.

Wood, W. E. 1950. Rangeland use in California. Jour. Range Mgt. 50: 204-212.

Literature References

Coastal and Bottomland Wet Forests

Austin, M. E.

Beals, E. W. and J. B. Cope. 1964. Vegetation and soils in an eastern Indiana woods. Ecology 45:777-792.

Blomquist, H. L. 1940. Introduction to the grasses of North Carolina. Mimmeographed copy, Duke University, 8 pp.

Caplenor, D. 1968. Forest composition on loessal and non-loessal soils in west-central Mississippi. Ecology 49:322-331.

Fenneman, N. M.

Golley, F., H. T. Odum, and R. F. Wilson. 1962. The structure and metabolism of a Puerto Rican red mangrove forest in May. Ecology 43:9-19.

Halls, L. K. 1970. Growing deer food amidst southern timber. Jour. Range Mgt. 23:213-215.

Kelsey, H. P. and W. A. Dayton, Editors. 1942. Standardized plant names. J. Horace McFarland Co., Harrisburg, Pa., 675 pp.

Lemon, P. C. 1945. Wood as a substratum for perennial plants in the southeast. The American Midland Naturalist 34:744-749.

Porter, C. L., Jr. 1967. Composition and productivity of a subtropical prairie. Ecology 48:937-942.

Williams, R. E., J. T. Cassady, L. K. Halls, and E. J. Woolfolk. 1955. Range resources of the south. Bulletin N.S.-9, Georgia Agric. Exp. Sta., U. of Georgia.

Literature References

Wet Grasslands

Austin, M. E. 1965. Land resource regions and major land resource areas (exclusive of Alaska and Hawaii). Agri. Handbook 296. Soil Conservation Service, U.S.D.A., Washington, D. C., 82 pp.

Fenneman, N. M.

Halls, L. K. 1957. Grazing capacity of wiregrass-pine ranges of Georgia. Jour. Range Mgt. 10:1-5.

Porter, C. L. 1967. Composition and productivity of a subtropical prairie. Ecology 48:937-942.

Rummell, R. S. 1957. Beef cattle production and range practices in south Florida. Jour. Range Mgt. 10:71-78.

Shelford, V. E. 1963. The ecology of North America. University of Illinois press, Urbana, 610 pp.

Shiflet, T. N. 1963. A conservation program for grazing woodlands in the southeast. Jour. Range Mgt. 16:18-21.

Shiflet, T. N. 1963. Major ecological factors controlling plant communities in Louisiana marshes. Journ. Range Mgt. 16:231-235

Southwell, B. L. and R. H. Hughes. 1965. Beef cattle management practices for wiregrass-pine ranges of Georgia. Bulletin N.S. 129, Georgia Agri. Exp. Sta., U. of Georgia.

Williams, R. E. 1958. Practical range management in the South. Jour. Range Mgt. 11:270-274.

Williams, R. E., J. T. Cassidy, L. K. Halls, & E. J. Woolfolk. 1955. Range resources of the South. Bulletin N.S. 9, Southern Section ASRM and Georgia Agri. Exp. Sta., U. of Georgia, 31 pp.

Yarlett, L. L. 1965. Control of saw palmetto and recovery of native grasses. Jour. Range Mgt. 18:344-345.

Yarlett, L. L. and Roush. 1970. Creeping bluestem (**Andropogon** stolonifer (Nash) Hitchs). Jour. Range Mgt. 23:117-122.

Literature References

Fauna

Bent, Arthur Cleveland. 1961. Life Histories of North American Birds of Prey. Part 1. Dover Publications, Inc., New York. 409 p.

Bent, Arthur Cleveland. 1961. Life Histories of North American Birds of Prey. Part 2. Dover Publications, Inc., New York. 482 p.

Bent, Arthur Cleveland. 1963. Life Histories of North American Gallinaceous Birds. Dover Publications, Inc., New York. 490 p.

Cadbury, J. and A. D. Cruickshank. 1942. Breeding - bird census, climax red and white spruce forest. Aud. Mag., Sec. 2, Sept-Oct:32.

Ely, Alfred. 1939. North American Big Game. Chas. Scribner's Sons, New York. 533 p.

Johnson, D. W. and E. P. Odum. 1956. Breeding bird populations in relation to plant succession on the Piedmont of Georgia. Ecology 37:50-62.

Kendeigh, S. C. 1946. Breeding birds of the beech-maple-hemlock community. Ecology 27:226-245.

Kendeigh, S. C. 1961. Animal Ecology. Prentice-Hall, Inc., Englewood Cliffs, N. J. 468 p.

Palmer, Ralph S. 1954. The Mammal Guide. Doubleday and Co., Inc., Garden City, N. Y. 384 p.

Rasmussen, D. I. 1941. Biotic communities of the Kaibab Plateau, Arizona. Ecol. Monog. 11:229-275.

Shelford, Victor E. 1963. The ecology of North America. Univ. of Illinois Press, Urbana. 610 p.

Smith, W. P. 1944. Breeding bird census, white pine-hemlock forest. Aud. Mag., Sect. 2: Sept.-Oct., 24.

Taylor, Walter P. 1956. The Deer of North America. The Stackpole Co., Harrisburg, Penn., and the Wildlife Mgt. Institute, Washington, D.C. 668 p.

U.S.D.I., Bureau of Sport Fisheries and Wildlife. 1968. Rare and Endangered Fish and Wildlife of the United States. Resource Publ. 34.

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